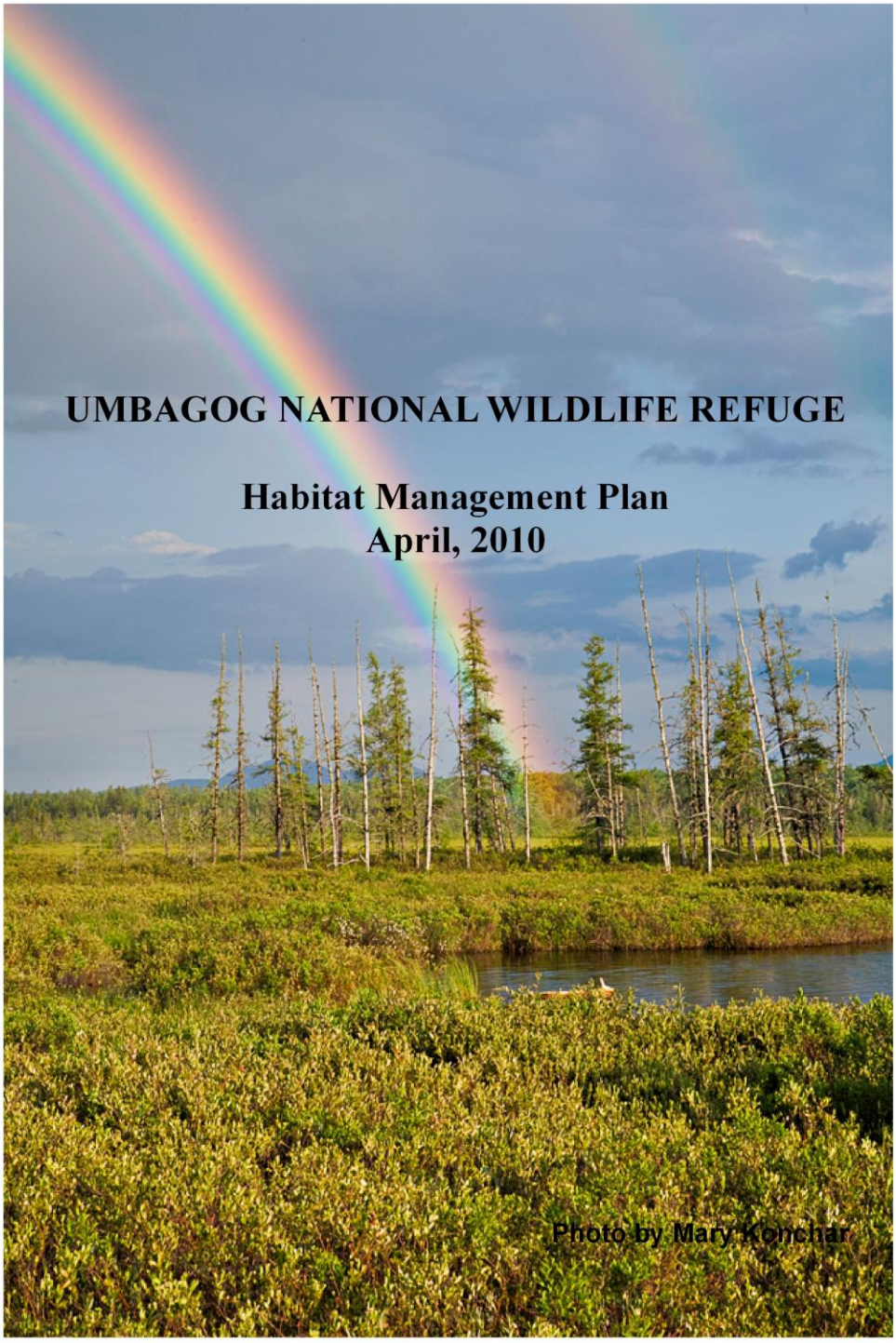
UMBAGOG NATIONAL WILDLIFE REFUGE
Habitat Management Plan
April, 2010
Photo by Mary Konchar

Umbagog National Wildlife Refuge Habitat Management Plan

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Chapter 1. Introduction

1.1 Scope and Rationale

The mission of the National Wildlife Refuge System is to *administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans*. The landmark 1997 National Wildlife Refuge System Improvement Act, prepared the way for a renewed vision for the future of the refuge system where

- Wildlife comes first
- Refuges are anchors for biodiversity and ecosystem-level conservation
- Lands and waters of the System are biologically healthy
- Refuges are national and international leaders in habitat management and wildlife conservation

Meeting the wildlife conservation challenges of the 21st century and fulfilling the System mission and vision requires planning and partnerships. The Comprehensive Conservation Plan (CCP) and Habitat Management Plan (HMP) for each refuge are essential to the System's ability to meet these challenges.

Umbagog National Wildlife Refuge (NWR) is in the Upper Androscoggin watershed in northern New England, one of the most rugged landscapes in the region. It is in the wilder northern part of the Androscoggin watershed, also known as the Northern Forest, a land of vast forests and lakes once populated by wolf, mountain lion, and lynx, and today habitat for moose and loon. The diversity of exceptional habitats provides regional breeding and migratory habitat for land birds and waterfowl and harbors species of conservation concern and rare plants. The Refuge protects over 25,665 acres with an approved 76,939 acre acquisition boundary in and around Umbagog Lake, with a vision of perpetuating the diversity and integrity of boreal and riverine wetlands, lake habitats, and the upland mixed spruce-fir/ northern hardwood forest, for the continued health of native fish and wildlife populations.

This HMP provides a long-term vision and specific guidance on managing habitat for the resources of concern at Umbagog NWR. The contributions of this Refuge to ecosystem and landscape scale wildlife and biodiversity conservation are incorporated in the HMP. The HMP sets a direction for the next 15 years (2010-2024) with plan review every 5 years and use of adaptive management to assess and modify management activities as research and monitoring may require.

1.2 Legal Mandates

Lake Umbagog NWR was established by Congress in 1992 for:

"the conservation of the wetlands of the nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions" [Emergency Wetlands Resources Act of 1986; 16 U.S.C. 3901(b)];

"for use as an inviolate sanctuary, or for any other management purpose, for migratory birds"[Migratory Bird Conservation Act; 16 U.S.C. 715d];

"for the development, advancement, management, conservation, and protection of fish and wildlife resources…" [Fish and Wildlife Act of 1956; 16 U.S.C. 742f(a)(4)]; and
"for the benefit of the United States Fish and Wildlife Service, in performing its activities and services…"[16 U.S.C. 742f(b)(1)]

1.3 Links to Other Plans

Refuge Plans

Comprehensive Conservation Plan (CCP)

Umbagog NWR completed a Comprehensive Conservation Plan in January of 2009. This plan will guide management decisions and actions on the Refuge for the next 15 years (2009-2023). Over 4000 acres have been added to the refuge since the Final CCP/EIS was published in 2008 (1565 acres in Maine and 2,450 acres in New Hampshire). The HMP is a step-down plan of the CCP. Habitat goals and objectives developed in the CCP are carried forward to the HMP.

Inventory and Monitoring Plan (IMP)

The IMP is also a step-down plan from the CCP and HMP and will be completed within two years of the finalized HMP.

Fire Management Plan

A FMP is mandated by the U.S. Fish and Wildlife Service (Service) policy for any Refuges that have "vegetation capable of sustaining fire". The fire plan addresses wildland and prescribed fire events with guidelines on the level of protection needed to ensure safety, protect facilities and resources, and restore and perpetuate natural processes. A draft Fire Management Plan was published along with our draft CCP/EIS in 2008. However, since the publication of the draft CCP/EIS, new requirements have been developed for FMPs. In order to incorporate these new requirements, a revised FMP is currently under development and will be finalized within 2 years of completion of the CCP. The FMP will be consistent with the goals and objectives in the HMP.

State and Regional Plans

USFWS Migratory Bird Program (MBP) Strategic Plan

The Migratory Bird Program completed a 10-year strategic plan in January 2004 (USFWS 2004). Refuges provide high quality habitat for many migratory birds. The MBP seeks to conserve and manage migratory bird populations and their habitats. Two strategies to achieve these goals are bird population monitoring and habitat management. Refuges are currently conducting biological surveys and managing habitat. The HMP recognizes the opportunity for using standardized monitoring protocols and habitat assessments on Refuges, contributing to region-wide assessments of population trends and effects of habitat management on migratory birds.

North American Bird Conservation Initiative (NABCI)

The NABCI brings together the landbird (Partners in Flight), shorebird, waterbird, and waterfowl plans into a coordinated effort to protect and restore all native bird populations and their habitats in North America. All bird conservation partnerships reduce redundancy in the structure, planning and implementation of conservation projects. It utilizes Bird Conservation Regions (BCRs) to guide landscape scale, science-based approaches to conserving birds and their habitats. Umbagog NWR is in BCR 14.

State Wildlife Action Plans

In Fall 2001, Congress established a new "State Wildlife Grants" (SWG) program that provided funds to state wildlife agencies for the conservation of fish and wildlife and their habitats. Each state was charged with developing a Wildlife Action Plan by 2005. Umbagog NWR consulted

both the New Hampshire Fish and Game Department's Wildlife Action Plan and Maine's Comprehensive Conservation Strategy in formulating the Umbagog Comprehensive Conservation Plan.

A complete list of plans that were considered in the formulation of the Umbagog CCP may be found in Chapter 1 of the Umbagog National Wildlife Refuge CCP (USFWS, 2009)

Chapter 2. Background

2.1 Refuge Location and Description

The 25,670-acre Umbagog NWR straddles the border of New Hampshire and Maine in Coos County, NH and Oxford County, ME (see Map 2-1, this document, and Umbagog NWR CCP (USFWS, 2009) for maps of the project area). The Refuge is approximately 25 miles north of Berlin, New Hampshire and approximately 30 miles south of the U.S. and Canada border.

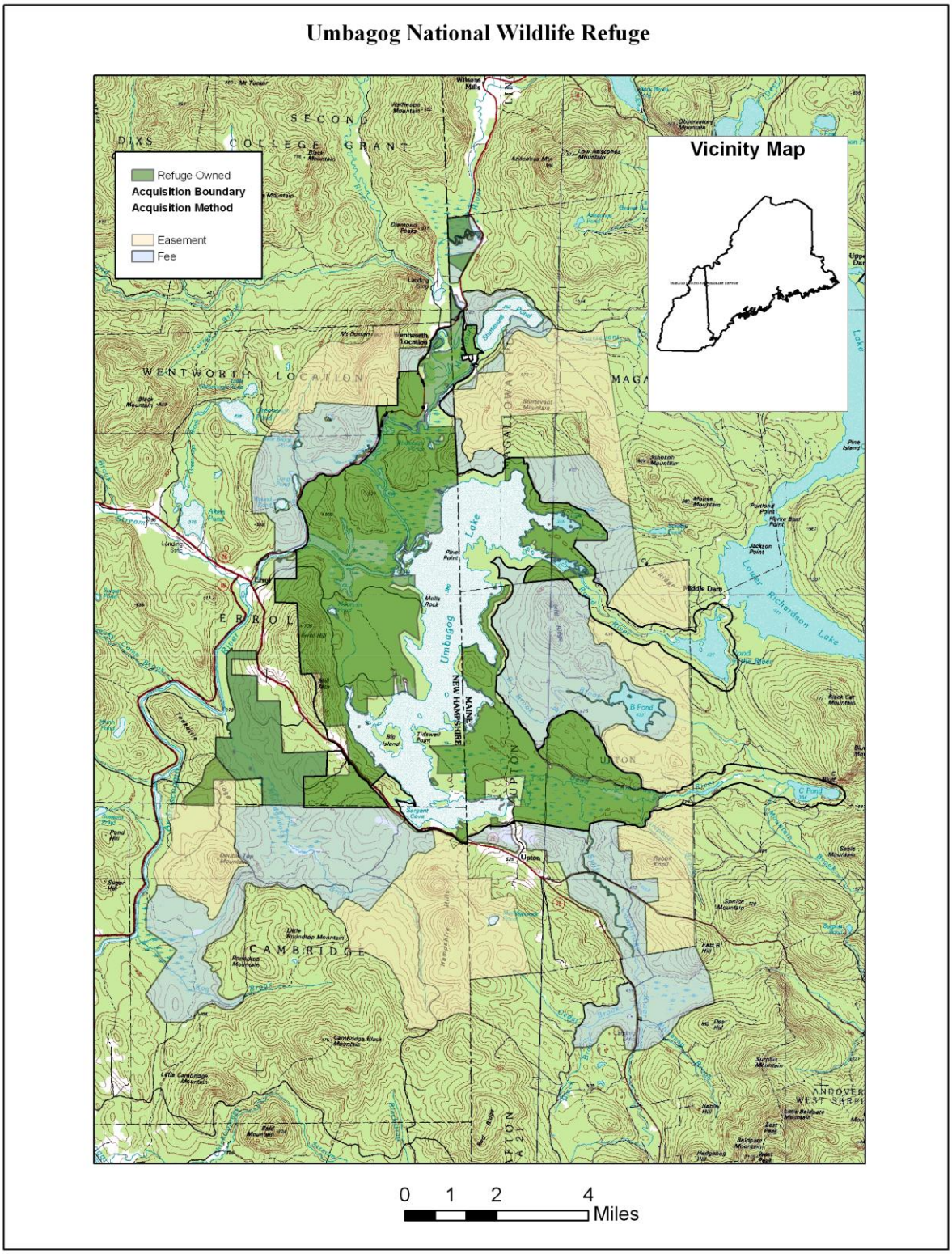
The centerpiece of the Refuge, Umbagog Lake, is the westernmost lake of the Rangeley chain and it is associated with several major rivers. Waters leaving Aziscohos Lake flow into Umbagog via the Magalloway River from the north. Water from all the other Rangeley Lakes enters Umbagog from the east through the Rapid River. All of the water moving through the Rangeley Lake system flows through Umbagog Lake and down the Androscoggin River. The Dead and Swift Diamond Rivers drain a larger watershed to the northwest. The Dead Cambridge River flows into the southeast end of the lake and other smaller watershed streams drain into the lake (USFWS 1991).

About one quarter of lands currently in Refuge fee ownership are wetlands. Refuge wetlands are among the most extensive and diverse in the Upper Androscoggin watershed and include several types of communities including, floodplain forest, northern white cedar swamp/forest, black spruce bog, boreal fens and bogs, emergent marsh, scrub-shrub, and wet meadow.

The Refuge includes relatively little current and former agricultural land. The Potter Farm at the southern end of the lake and holdings along the Magalloway River include both open and reverting fields. Much of the uplands, in industrial forest ownership prior to acquisition by the Refuge, were subject to a century and a half of timber harvest. The dominant forest type is mixed woods with varying amounts of spruce- fir and northern hardwoods habitat.

The original surface area of Umbagog Lake was expanded nearly five-fold with the construction of the original Errol Dam in 1853 and its subsequent replacement in the 1880s. The dam raised the water levels in Lake Umbagog approximately seven feet and greatly increased the size of the lake from 1,000 acres prior to the dam to over 7,000 acres today (USFWS 1991).

Map 2-1. Umbagog National Wildlife Refuge.



2.2 Management Units

Management unit boundaries were determined based on habitat type, similarity of management approach and management logistics. The goal was to create units that could be managed ecologically, be recognized by Refuge staff, and that made sense from a logistical standpoint. Map 5-1 shows refuge management units. As new lands are acquired, existing management zones will either be expanded to incorporate the new areas, or new management units will be designated, as appropriate. Within each management unit one or more treatment areas may be delineated where and when management prescriptions are implemented. A patch cut within a forest stand or an area treated for invasive plants are examples of a treatment area within a management unit. Our management prescriptions include silvicultural techniques and invasive plant removal, among others. The HMP provides guidance on the configuration and conservation actions for management units. Chapter 5 describes the management unit prescriptions in more detail.

The Refuge will designate and track management units and treatment areas compatible with the RMAD and other national databases being developed by the Refuge System.

2.3 Geographic Setting

Ecoregion
The Nature Conservancy (TNC) has divided the continental United States into 63 ecoregions—large geographic areas that share similar geologic, topographic, ecological, and climatic characteristics. These ecoregions are modified from the U.S. Forest Service "Bailey System". TNC is developing Ecoregional Conservation Plans that identify conservation targets and prioritize conservation actions. Umbagog NWR is in the Northern Appalachian/Boreal Ecoregion (NAP). The NAB ecoregion extends from Tug Hill and the Adirondacks in New York, across the Green and White Mountains, stretching north through most of Maine, and into Canada. This region is characterized by expansive forest dominated by spruce-fir and northern hardwoods, diverse topography from sea level to over 5000 feet in elevation, thousands of lakes, ponds, rivers and wetlands, and rugged coastline. Warm summers and long, cold winters typify the climate.

The Umbagog area is described by the U.S. Forest Service's ecoregional classification system (Bailey 1995) as:

Domain:	Humid Temperate
Division:	Warm Continental
Province:	Adirondack-New England Mixed Forest
Section:	White Mountain
Subsection:	Mahoosuc-Rangeley Lakes
Landtype Associations:	Valleys with Silty Substrate & Hills and Slopes of Low Mountains

Bird Conservation Region and PIF Physiographic Area
Umbagog NWR lies within Bird Conservation Region BCR 14, the Atlantic Northern Forest. BCR 14 is characterized by nutrient-poor soils that support spruce-fir forests in the north and at higher elevations and northern hardwood forests on lower slopes and elevations (see Dettmers, 2005 for more details). The Refuge is within PIF Area 28 (Eastern Spruce-Hardwood), a subregion of BCR 14.

Atlantic Coast Flyway
This Refuge is within the Atlantic Flyway. Flyways have been used for many years in North America as the unit for managing waterfowl populations because they allow land managers to link efforts to conserve migratory bird species and their habitats on breeding, migration, and wintering grounds. The Atlantic Coast Joint Venture area includes the entire U.S. Atlantic Coast lying completely within the U.S. portion of the Atlantic Flyway. In this large area, the JV partners work together to assess the status, trends, and needs of bird populations and their habitats. The partners then use this information to help guide the distribution of resources to the needs/issues of highest priority.

Broad Vegetation Zones
Land cover data (e.g., NLCD, cover type maps) describe a habitat condition at a specific point in time and don't necessarily describe potential vegetation or successional trajectories. Maps of potential vegetation by Westveld et al. (1956) and Kuchler (1964) depict broad vegetation zones for New England. Umbagog NWR is within the northern hardwoods-spruce ("mixed forest") broad vegetation zone.

Upper Androscoggin River Watershed
Umbagog NWR is within the Upper Androscoggin River watershed and the lake serves as the headwaters of the Androscoggin River. The Magalloway River drains the upper part of the watershed before flowing into Umbagog Lake. The Androscoggin River, which ultimately drains an area of over 3,400 square miles in New Hampshire and Maine, flows west out of the Lake and then meanders south and east to where it eventually joins with the Kennebec River in Merrymeeting Bay, before entering the Gulf of Maine, a distance of 164 miles.

Regional Land Ownership and Conservation Context
The economy of the area is heavily dependent on forestry and seasonal recreation. Forest products (timber and pulp) companies are the major landowners in the region. Lands around Umbagog Lake are primarily forested or in some stage of post-harvesting. In 1990 Maine, Vermont, and New Hampshire created the Northern Forest Lands Council to seek ways to maintain the "traditional patterns of land ownership and use" (Northern Forest Lands Council 1994). Of concern was the potential for major shifts in land ownership and use away from traditional uses. Current trends in ownership patterns indicate that this concern is still valid. In 2008, the population of Coos County was 31,971, a 3.4 percent drop from 2000, and Oxford County was 56,741, a 3.6 percent increase from 2000. Around Umbagog Lake a small percentage of the river and lake shorelines have been cleared for development of small recreational cabins. These areas include the southern shore of Tidswell Point, much of Thurston Cove, and stretches of the Magalloway known as "Little Berlin". The number of visitors to the Umbagog NWR has increased every year since it has opened, from an estimated 442 individuals in 1993 to over 50,000 visitors in 2008 (see Appendix G, Umbagog NWR CCP/EIS (USFWS, 2008) and USFWS, 2009). Manning (2009), estimated approximately 6,500 visitors engaged in boating on Umbagog Lake in July and August, alone.

2.4 Historical Perspective of New England's Ecological Landscape

After the Ice Age
Twelve thousand years ago New England emerged from an ice age. Ice a mile thick scraped and molded the valleys, slopes, and mountain tops, leaving behind a landscape bare of vegetation. At the southern edge of the glacier, however, plants survived and immediately began to re-colonize the newly exposed soils (Marchand 1987).

Continual weathering and erosion of rock over time released nutrients and created new soils for plants to grow. The tundra-like landscape was dominated by sedges and dwarf shrubs for several thousand years. As the climate warmed, these plants and animals followed the glacier as it receded north. The tundra continued to retreat, eventually restricted to the highest mountaintops (Davis 1983, Marchand 1987).

Hardwood and softwood tree species advanced independently of one another creating different forest communities through time (Davis 1983). Graham (1992) reported a similar individualistic response by mammals to the post-glacier climate changes. Spruces were the first trees to colonize, nearly 2,000 years after the ice melted. Pollen records show balsam poplar and dwarf birch in the mix with spruce (Davis 1983). The sequence of plant species arrivals as the glacier receded was different at different sites (Davis 1981).

About 10,000 years ago spruce declined over a wide area, replaced by a more diverse community of conifers including jack, red and white pine, balsam fir and hardwoods (birch, elm, oak, ash, hornbeam, and ironwood). Alder reached peak abundance as spruce declined (Davis 1981, Davis 1983, Pielou 1991, DeGraaf and Yamasaki 2001). In Northern New England northern hardwoods—American beech, sugar maple, and yellow birch—established their dominance 2,000 years ago while spruce regained dominance on the middle slopes (Davis 1981, Davis 1983, Marchand 1987, Pielou 1991).

Pre-European Settlement

Native Americans were growing crops and cutting the forests for fuel long before Europeans arrived. Native peoples set fires in the forests to aid in hunting and travel (Marchand 1987). Much of the literature and habitat management prescriptions by natural resource entities are based on the assumption that grasslands, heathlands, and shrublands (collectively called "open land") were prevalent in the pre-European New England landscape. Native prairies, extensive beaver meadows, periodic fires, shifting agriculture, and occasional hurricanes created a "shifting mosaic" of open land habitat within the forested landscape (Cronin 1983, DeGraaf and Yamasaki 2001). DeGraaf and Yamasaki (2001) and Askins (2000) report broad evidence for the presence of extensive grasslands along the coast and major rivers in pre-European New England.

Askins (2000) contemplates the reasons for the high abundance of grassland species (e.g., upland sandpiper) reported in the Northeast by early ornithologists. He wonders if these species were here in the grassy savannas as the glacier receded and as forest spread northward the birds hung on in low-lying sandy areas of the coastal plain where human activity and large-scale disturbances such as hurricanes and fire may have sustained pockets of grassland and shrubland habitats.

Ecologists and historians agree that pre-European New England was influenced by cultural and natural processes. However, Foster and Motzkin (2003) suggest that little historical evidence exists for the widely accepted idea that extensive areas of open upland existed in pre-settlement times. Their research of pollen records indicates that the landscape was dominated by mature forest with localized patches of upland grasslands and shrublands before European arrival. Low-intensity natural disturbances including wind, ice and insects were frequent and local, while higher-intensity large-scale disturbances including hurricanes, tornadoes, and insect epidemics were infrequent. Beavers created extensive wet meadow habitat, although there is no evidence that large grazing animals would have maintained open areas in the uplands (Foster and Motzkin 2003).

Foster and Motzkin's (2003) review of the archeological and paleoecological literature reveal varying accounts of the land use patterns of pre-European New England people. They suggest an emerging view that the native populations were mobile and practiced shifting agriculture, creating a mosaic of forest ages, but not extensive areas of cleared land (that would result in extensive grasslands, heathlands, or shrublands).

Researchers agree that the historical record offers clear evidence of use of fire by Native Americans (Foster and Motzkin 2003). Indians burned the forest understory to improve travel and for hunting game such as white-tailed deer (DeGraaf and Yamasaki 2001). Deer were the most common bones found in archaeological sites in southern New England (DeGraaf and Yamasaki 2001, Foster and Motzkin 2003).

Use of prescribed burning as a habitat management tool by public and private conservation groups is based, in part, on the premise that that open land habitats "…were managed with fire for thousands of years by Native Americans", as stated by the Massachusetts Department of Fisheries and Wildlife (Foster and Motzkin 2003). According to Russell (1983), the frequent use of fire by indigenous people was likely a local occurrence and the overall impact of these fires on the landscape may be overstated in the historical literature. Patterson and Sassaman (1988) note little agreement on the extent to which indigenous people influenced vegetation changes through use of fire. They suggest that more sedentary and concentrated indigenous populations in coastal southern New England, likely set repeated fires that had a more lasting impact on the landscape. In interior and northern New England tribes were more mobile, traveled by canoe rather than on foot, gathered food from rivers and the sea rather than agriculture, and rarely used fire.

Lorimer (1977) analyzed historic land survey records of northern Maine, to assess the pre-settlement forest. He described the forest in the region as a predominantly all-aged mixed forest. Pure stands of hardwoods or softwoods were not common. Hardwood forests occurred on mostly good upland soils, free of rocks. Spruce stands occurred on mostly poor soils in low "stony flats" or on upper mountain slopes. Cogbill et al. (2002) analyzed records of witness trees from presettlement land surveys to reconstruct tree species distributions in New England. They describe a "tension zone" separating the northern forests dominated by beech from the southern forests dominated by oak. A mixture of hickories and chestnut occurred with oaks in the south, while the northern areas contained a mix of beech, hemlock, birch, spruces, and maples. Oak and pine showed a northward extension up major river valleys. Beech and hemlock showed a complementary southward extension in the uplands.

European Settlement

When colonists landed on Massachusetts shores in the early 1600s they saw large clearings and open woodlands. Waterfowl, deer, grouse, turkey, and wild pigeons were abundant (Marchand 1987, Foss 1992, DeGraaf and Yamasaki 2001). Colonists found old growth forests not far inland—mixed hardwoods, white pine and hemlock at low elevations and spruce and fir in the mountains (Marchand 1987). In northern New England native people and early Europeans didn't utilize agriculture so the landscape remained blanketed in forest (DeGraaf and Yamasaki 2001).

Many writers point to the abundance of the heath hen in the mid 1600s, as recorded by 17th century Bostonians, as a clear indication of an open, prairie-like landscape (DeGraaf and Yamasaki 2001). Foster and Motzkin (2003) discount the claims of heath hen abundance and preference for grassland habitats. The heath hen, a subspecies of the prairie chicken, was more likely a bird of open sandy woods and scrub oak barrens. European contact (e.g., explorers and traders) with native people began in the 16th century in New England. Foster and Motzkin (2003) suggest that European arrival prompted such rapid and profound changes to the lifestyle and land

use practices of indigenous people that by the time colonists began to settle here, the landscape was already changing quickly. Foster and Motzkin (2003) suggest that expansive clearing for agriculture and semi-permanent (rather than mobile) villages were a new phenomenon and resulted from European influence.

European colonists brought new land use concepts such as permanent settlements and political boundaries. They shifted land use from primarily subsistence farming and gathering to harvesting and export of natural resources (Foss 1992). Just 100 years after the colonists arrived, the forests were falling quickly to the axe. By 1830, central New England was 80% cleared. By some estimates, all commercial softwood was gone from the White Mountains by 1890 (Marchand 1987). In Maine, commercial logging for pine began as early as 1650 and all forest types have been cut since 1850 (Lorimer 1977).

Even more quickly than the fall of the forest, the rough, rocky New England landscape was abandoned. The California gold rush, industrial revolution, new railroads, richer Midwestern soils, and the Civil War all contributed to the exodus. Abandoned farm fields began reverting back to forest. White pine seeded into the fields and pastures and by 1900 was ready for harvest (Marchand 1987, DeGraaf and Yamasaki 2001). Between 1895 and 1925, 15 billion board feet of lumber was logged from central New England. An understory of hardwoods, released from the shade of white pine, emerged as the new dominant vegetation, a legacy that remains today (Marchand 1987, DeGraaf and Yamasaki 2001).

Wildlife Changes

Wildlife populations ebb and flow as habitat conditions vary in space and time. Natural and human disturbances intervene, shifting species abundance and diversity. Some species, such as alpine plants, have been here for 10,000 years or more, others, like the coyote, arrived in the last 75 years. Change is inevitable and natural, although human activities in the last 400 years have significantly altered the landscape compared to the previous 10,000 years when humans first colonized the Northeast (Foss 1992).

The 1800s witnessed the demise of many forest wildlife species from loss of habitat (forest clearing), bounty and market hunting, millinery trade, and natural history specimen collecting (Foster et al. 2002). Mountain lion, gray wolf, elk, and caribou were extirpated by the mid 1800s or early 1900s and only the gray wolf has recently returned (in small numbers in Maine) to the region. Heath hen, passenger pigeon, great auk, Labrador duck, and sea mink became extinct at the hand of humans during the same period (DeGraaf and Yamasaki 2001, Foster et al. 2002).

In contrast, grassland species such as meadowlarks, bobolinks, upland sandpipers, woodchucks, and voles increased as hayfields and pastures expanded during the early 19th century (Foss 1992, Foster and Motzkin 2003). Open land plant and animal species reached their peak abundance in the mid 1800s. The historical record is unclear on the abundance and distribution of these species prior to the surge in farming. Foster and Motzkin (2003) suggest that open land species were opportunistic, expanding into newly cleared lands from small, scattered populations in the pre-settlement era. Other species expanded their range into New England from the Midwest. DeGraaf and Yamasaki (2001) consider grassland and shrubland birds as specialists that occupied native grasslands and shrublands in the region prior to the massive land clearing.

After farm abandonment escalated in the early 1900s, grassland species ebbed, while species of thickets, brush lands, and young forests surged (Litvaitis 2003). Populations of black bear, bobcat, and broad-winged hawks increased. At the same time, intense logging followed by intense fires and heavy rains continued to wreck havoc on forest habitat and associated wildlife

species in northern New England. The legacy of this devastation is evident today. Many barren mountaintops below 3,800 feet and hardwood dominated hillsides are artifacts of early 20th century land use (Foss 1992, DeGraaf and Yamasaki 2001).

The young hardwood forests that emerged in the 1920s and 1930s after the old-field pine harvests provided premier habitat for ruffed grouse (DeGraaf and Yamasaki 2001). The succession of that forest into mature hardwood forests in the late 1900s caused a decline in the grouse population but an increase in other species that prefer more mature forests. Abundances of early successional species declined to levels approaching pre-settlement levels (Litvaitis 2003).

Eastern coyotes were first sighted in Vermont and New Hampshire in the 1940s, northern Maine in the 1930s, and in Massachusetts in the 1950s. The turkey vulture, tufted titmouse, northern mockingbird, and Virginia opossum are newer arrivals. Wild turkeys, re-introduced in the 1960s and 1970s, are flourishing well beyond their historic ranges. Fisher, black bear, moose, pileated woodpecker, and other forest species have mostly re-colonized the region (DeGraaf and Yamasaki 2001).

Humans have deliberately and inadvertently introduced many species that have had significant effects on native ecosystems. It took the chestnut blight only 50 years, once introduced, to eliminate the chestnut as a dominant tree across its range. Intentional introductions include ring-necked pheasant, red fox, and rock dove. Norway rat, house sparrow, and starling have adapted well to human habitation after their arrival in the U.S.

The widespread use of DDT in the mid-twentieth century killed many songbirds and decimated populations of many birds of prey (Foss 1992). Discontinued use of these and other pesticides along with strong conservation efforts enabled many of these species to recover. Unfortunately, many species of wildlife continue to be exposed to a variety of environmental contaminants in the United States and on their wintering grounds in South and Central America that adversely affect their survival and productivity rates.

DeGraaf and Yamasaki (2001) report three major trends in New England's wildlife: forest species are increasing (e.g., bear, beaver, deer, wild turkey, pileated woodpecker), grassland and shrubland species are declining (e.g., grasshopper sparrow, bobolink, upland sandpiper, whip-poor-will), and many southern species are expanding their ranges northward (e.g., glossy ibis, willet, Carolina wren, northern cardinal, mockingbird, Virginia opossum). A few species, such as raven, fisher, and moose are expanding southward.

The open land habitats of colonial times are largely gone. In southern New England most of the native prairie (whatever the extent in pre-settlement times) is developed and wetlands are filled and isolated, diminishing the extent and dynamics of beaver flowages and meadows. The intensive agricultural period that kept land open is also over. The amount of timberland (i.e., forest cover) in northern New England has remained stable over the last 50 years at about 82% of the land area. Timberland in southern New England declined over the same period from 64% to 58% of total land area (Brooks 2003).

A group of species remains regionally extirpated including wolverine, gray wolf, and mountain lion, while lynx have returned to northern Maine. Habitat loss and human development are contributing to the ongoing declines of a majority of grassland and shrubland birds. Remnant patches of these habitats are now embedded in a fragmented landscape conducive to generalist predators (Litvaitis 2003).

Changes in habitat distribution and quality resulting from ongoing climate change, will result in new pressures on wildlife, including changes in species ranges and wildlife community composition. Upland boreal species closely tied to conifer forest, including spruce grouse, three-toed and black-backed woodpecker, gray jay, bay-breasted and Cape May warblers, and snowshoe hare, are likely to experience declines. Other species, whose center of distribution is currently more to the south, may expand their ranges in New England. Examples include: tufted titmouse, northern mockingbird, golden-winged warbler, and northern cardinal, among others. Many wetland bird species may also experience declines. Species expected to experience declines due climate-related wetland degradation include: American bittern, common loon, and sora. Other wetland species, such as green heron and great egret may expand their ranges in the coming years.

2.5 Climatic Influences and Natural and Anthropogenic Disturbances in New England

"It is said that nowhere else at the same latitude in the northern hemisphere is it as cold as in the Northeast, except perhaps in northeastern China and Hokkaido, Japan" (Marchand 1987). The reason for the region's cold climate is partly a result of the pattern of atmospheric circulation in this hemisphere. Low-pressure systems all converge on New England regardless of their origin and pull cold Canadian air in behind as they pass over the northeast (Marchand 1987). New England weather conditions are influenced more by the North American landmass than by the Atlantic Ocean except along the coastline (Taylor et al. 1996). Forty to forty-five inches of precipitation fall about evenly throughout the year, although drought periods occur in some years (Patterson and Sassaman 1988).

Natural disturbances vary across New England, depending on geographic location, forest type, and local conditions (e.g., hurricane damage is greater on exposed versus sheltered slopes, lightning fires are more frequent on exposed ridges and on sandy versus loamy soils). Global climate changes also affect natural disturbance patterns over time (Lorimer 2001).

In presettlement times coastal regions experienced the highest rates of disturbance because of the prevalence of sandy pine-oak barrens, high densities of Native Americans, higher frequencies of hurricanes, and longer snow free periods. These disturbance regimes may have maintained about 1-3% of the inland northern hardwoods forests, >10% of the coastal pine-oak barrens, and perhaps 7% of spruce swamp and spruce flat habitats in early successional habitat (Lorimer and White 2003).

Native insects and disease, ice storms, droughts, floods, landslides, and avalanches have caused minor and major disturbances. For example, spruce budworm periodically affects millions of acres of spruce-fir forest in northern New England and southern Canada and the 1998 ice storm damaged forests across 12 million acres in northern New England (DeGraaf and Yamasaki 2001). Lorimer and White (2003) depict hurricane frequencies as varying from 85 years in southeastern New England, 150 years through central Massachusetts and the southeast corner of New Hampshire, to 380 years or more in northern New England. Lorimer (1977) estimated catastrophic disturbances from fire and windthrow at intervals of 800 and 1,150 years, respectively. In contrast, small gap disturbances were frequent in our forests and may have occurred at scales smaller than what are currently delineated as "stands" today (Seymour et al. 2002).

Agriculture, logging, fire, windthrow, exotic pests and diseases, and development have significantly altered the New England landscape. Agriculture had the greatest effect on New England's forests, causing major changes in cover types and soils over a wide area. Although

most of the region's forests were cut at least once, most logging did not affect succession or impact soils. Intense fires fueled by logging slash did have a lasting impact on forest vegetation patterns (DeGraaf and Yamasaki 2001).

2.6 Current Condition

Climate

The climate of the Upper Androscoggin Watershed is temperate continental, with warm summers, cold winters, and a relatively even distribution of precipitation throughout the year. The region has four distinct seasons. Winter temperatures, December through February, average only 14^{o} F, with minimum temperatures as low as -34^{o} F. Summer months, June through August, average 62^{o} F, reaching highs of 96^{o} F or more. Annual precipitation in the form of rain averages 33-39 inches and is evenly distributed throughout the year, but with greater amounts in the summer.

Since 1970, average temperatures in the northeast have increased by about 1.5 degrees F, with average winter temperatures increasing by about 4 degrees F. Some climate models predict that the rate of climate change will increase over the course of the next century to about 9-13 degrees F above historical levels in the winter, and 6-14 degrees higher in summer. The amount of winter precipitation is likely to increase as is the frequency and duration of summer droughts. More precipitation is likely to fall as rain, rather than snow (Frumhoff, et al. 2007).

The greatest effects of climate change will be on regional air and water temperatures, precipitation patterns, and storm intensity. These effects are predicted to influence natural disturbances by resulting in an increase of freeze-free periods, decreased snow cover and lake ice duration, increased storm intensities and frequencies, increased likelihood and frequency of droughts, damaging ozone, changes in season lengths, decreasing range of nighttime versus daytime temperatures, and an increase in the spread of invasive species and disease (NH WAP 2005). The resulting effects on wildlife and habitats are expected to be variable and species-specific, with a predicted general trend of ranges shifting northward. Impacts will likely be most severe for habitats with narrow temperature and water level regimes, such as high and low elevation spruce-fir forests, vernal pools, and aquatic habitats (NH WAP 2005).

Habitat Types

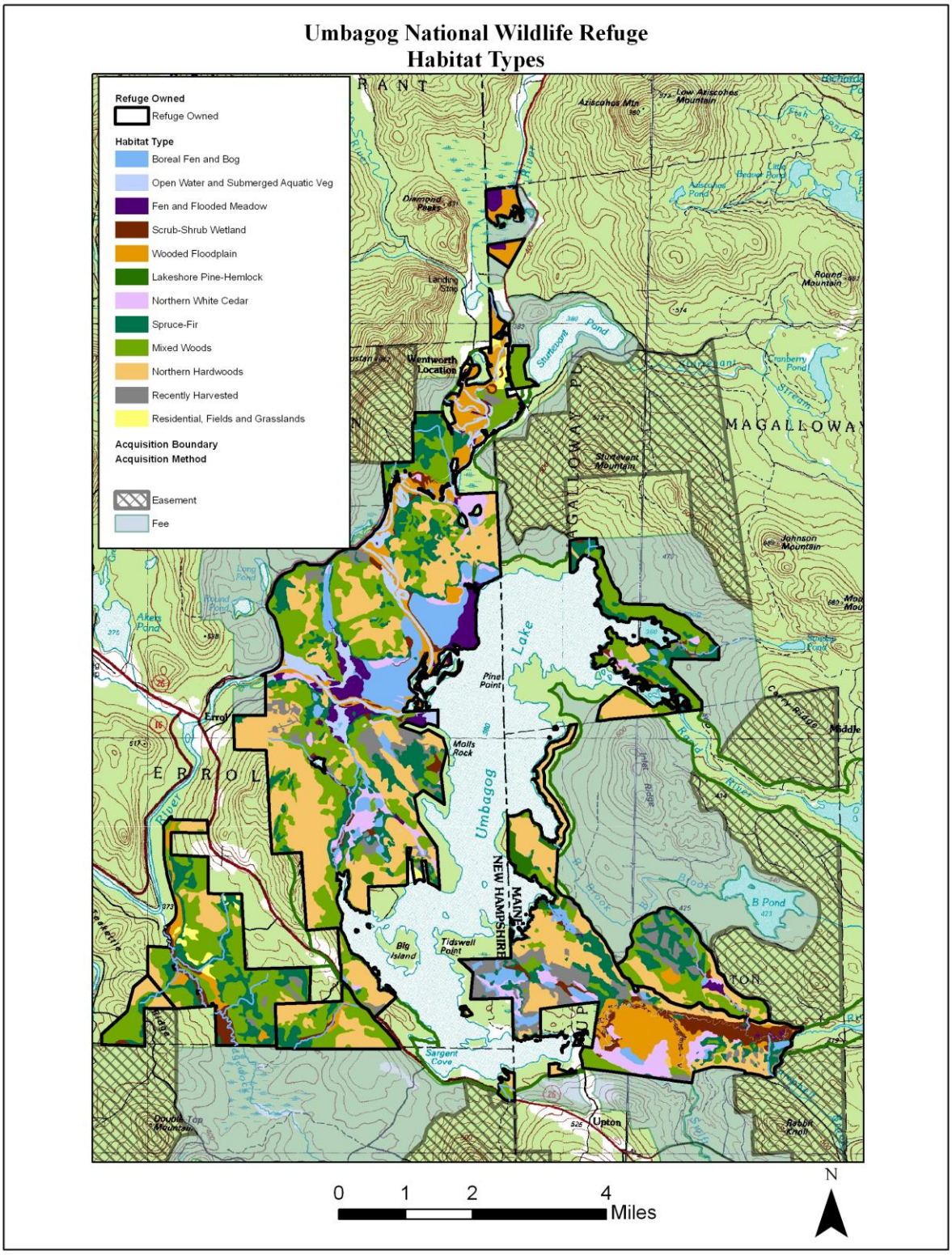
Table 2.1 summarizes the refuge's habitat types. Location of habitat types are shown in Map 2-2. Habitat types were derived them from several sources. Our primary source was a cooperative mapping project with the University of Vermont, Spatial Analysis Laboratory, using the NVCS (Rapp 2003). We supplemented those data with aerial photo flights and interpretation generated in 2004 by the James W. Sewall Company of Old Town, Maine. For lands acquired after 2004, broad habitat categories were derived from NLCD and NWI data. The acreages in the table are approximations based on digital boundary mapping and photo-interpretation using a GIS database. We grouped several natural communities into broader habitat types shown in Table 2.1. The habitat groupings provide a coarser, more practical scale for mapping and applying management actions in the field. Wildlife, our main management focus, typically responds to habitat conditions at that broader scale. In addition, many of the natural communities we have grouped under a single habitat type occur naturally together as an ecologically system, often with one community merging into another. Thus, they often function ecologically as one habitat. A more complete description of our habitat types, as well as a cross-walk to other vegetation classification systems, may be found in the Umbagog National Wildlife Refuge Comprehensive Conservation Plan (CCP) (USFWS, 2009).

Table 2.1. Umbagog National Wildlife Refuge Habitat Types

Habitat Type	NVCS Association (UVM 2003)	Approximate Acres owned by the refuge
Fen and Flooded Meadow	**Medium fen- wet phase** **Medium fen** **Cattail marsh** **Seasonally flooded mixed graminoid meadow** **Eastern tussock sedge meadow** **Spikerush shallow emergent marsh** **Few- seeded sedge-leatherleaf fen**	**566**
Boreal Fen and Bog	**Leatherleaf poor fen** **Medium shrub fen** **Sub-boreal dwarf-shrub fen** **Circumneutral pattern fen** **Spruce-fir swamp** **Black spruce wooded bog** **Black spruce-larch swamp**	**1,188**
Northern White Cedar	**Northern white-cedar- balsam fir peatland swamp** **Northern white-cedar-black ash swamp** **Northern white-cedar-boreal conifer mesic forest** **Northern white-cedar peatland swamp** **Northern white-cedar seepage forest** **Northern white-cedar wooded fen**	**839**
Scrub-Shrub Wetlands	**Speckled alder peatland lagg** **(Speckled, green) alder shrubland** **Speckled alder swamp** **Sweetgale mixed shrub thicket**	**886**
Open Water and Submerged Aquatic Vegetation	**Water**	**5,033**
Wooded Floodplain	**Red maple floodplain forest** **Red maple-balsam fir floodplain forest** **White spruce-balsam fir berm woodland** **Red maple-tussock sedge floodplain woodland** **Black ash-mixed hardwoods swamp** **Red maple-black ash swamp**	**1,572**
Lakeshore Pine-Hemlock	**Hemlock mesic forest** **Hemlock-hardwoods forest** **Hemlock-white pine- red spruce forest** **Red pine-white pine forest** **Jack pine/blueberry/feathermoss forest**	**232**
Spruce-fir	**Lowland spruce-fir forest** **Red spruce rocky summit** **Black spruce - red spruce forest**	**3,037**
Mixed Woods	**Aspen-fir woodland** **Successional spruce-fir forest** **Red spruce- hardwoods forest**	**5,692**

Habitat Type	NVCS Association (UVM 2003)	Approximate Acres owned by the refuge
Northern Hardwoods	**Early successional aspen-birch forest/woodland** **Red maple-yellow birch early successional woodland** **Northern hardwood forest** **Semi-rich northern hardwood forest** **Paper birch talus woodland**	**5,291**
Recently Harvested	**Recently disturbed**	**1,150**
Fields and Residences	**Residential**	**184**
TOTAL		**25,670**

Map 2-2. Umbagog NWR HabitatTypes.



Rare Plants and Exemplary Natural Communities
A number of rare plants and plant communities occur on the refuge, including such New Hampshire endangered species as meager sedge, narrow-leaved cotton grass, and livid sedge, among others. Several open peatland complexes on the refuge have been recognized as exemplary natural communities by the New Hampshire Heritage program. In 1972, part of the wetlands associated with the Harper's Meadow area of the refuge, were designated as the "Floating Island National Natural Landmark". A complete list of species and habitats of conservation concern may be found in the refuge's CCP (USFWS, 2009).

Invasive Species
The USFWS identifies an "invasive species" as a species that is 1) non-native (or alien) to the ecosystem under consideration and 2) whose introduction causes or is likely to cause economic or environmental harm or harm to human health (Executive Order 13112). The Executive Order requires the National Invasive Species Council (Council) to produce a National Invasive Species Management Plan (Plan) every two years. In January 2001, the Council released the first Plan, which serves as a blueprint for all federal action on invasive species. The Plan focuses on those non-native species that cause or may cause significant negative impacts and that do not provide an equivalent benefit to society. One report estimates the economic cost of invasive species in the U.S. at $137 billion every year (Pimentel et al. 2000). Up to 46% of the plants and animals federally listed as endangered species have been negatively impacted by invasive species (Wilcove et al. 1998, National Invasive Species Council 2001).

USFWS Region 5 initiated an effort to systematically identify, locate, and map invasive plant species occurring on refuge lands leading to an effective integrated management plan. Refuges will use this information to guide the development of control, monitoring and evaluation projects, particularly in the face of the predicted increase in invasive species likely to accompany climate change. The data will also be instrumental in developing refuge Integrated Pest Management Plans. The survey data will be collected and provided to the Regional GIS specialist for developing GIS coverages for refuges and consolidate regional coverages for prioritization initiatives for species control, monitoring rate of species spread, and evaluation.

The Refuge has not yet been systematically surveyed for invasive species. However, it appears that we have relatively few invasive plant species and those that are present are in low numbers. Purple Loosestrife *(Lythrum salicaria)* and Japanese knotweed (*Polygonum cuspidatum)* occur on the Refuge. A number of non-native fish have been introduced into Umbagog Lake, including smallmouth bass. There are some concerns that the bass may threaten a native brook trout fishery.

Environmental Contaminants
The northeastern U.S. has the highest levels of mercury deposition in the country (Evers and Reaman 1998). The Hubbard Brook Research Foundation (HBRF) released new and existing information that shows the connections between air emissions of mercury and mercury in fish and other aquatic life (Hubbard Brook Research Foundation, 2003). Studies at Umbagog Lake found elevated levels of mercury in loons and studies of mercury in fish (e.g., yellow perch) show mercury levels high enough to cause problems for loon reproduction. Water level fluctuation is one variable that effects the production of methylmercury. The inundation of shoreline wetlands, particularly peatlands, increases methylmercury loading into the water (Evers and Reaman 1998).

HBRF also reported on the impacts of nitrogen pollution from food and wastewater, fertilizers and fossil fuels on acid rain (see Driscoll et al. 2001, 2003), air quality, climate change, groundwater contamination, nitrogen saturation in forests, and eutrophication of coastal waters. There is growing consensus that global climate change is occurring as a result of emissions of carbon dioxide and other greenhouse gases from human activities that may lead to significant impacts across the U.S., adding stress to ecosystems (Wigley 2004).

Since wildlife species are closely adapted to their environments, they must respond to climate variations, and the subsequent changes in habitat conditions, or they will not survive. Unfortunately, the challenge for wildlife is all the more complicated by increases in other environmental stressors such as pollution, land use developments, ozone depletion, exotic species, and disease.

2.7 Guidance on Habitat Management

Populations of grassland, shrub land, young forest, and mature forest species fluctuated during the past four centuries as the proportion of their habitat was altered by sometimes rapid changes in land use across New England. DeGraaf and Yamasaki (2001) describe 338 regularly occurring inland vertebrates for New England. The distribution of each species within the region is influenced by latitude, topography, and land-use history. There are no accurate species lists for 2,500 or 250 years ago in New England, no baseline point to strive for (Foster 2000, DeGraaf and Yamasaki 2001).

The history of the New England landscape is important in guiding land management decisions. A historical perspective offers insight into ecological processes and ecosystem responses to environmental changes and provides for different yet compatible conservation strategies across the region (Foster 2000). According to Foster (2000), three conservation directions—wilderness preservation, natural resource use (e.g., timber harvesting), and "cultural restoration"—are valid and compatible given the history of New England's landscape. He refers to grasslands, heathlands, and shrublands as elements of our cultural history, influenced by recent (past 400 years) human land use practices. Intensive practices such as grazing, mowing, and timber cutting may replicate the land use patterns that created these habitats rather than "natural" processes such as prescribed fire (Foster 2000). Latham (2003) suggests that most shrublands in the northeast originated after European settlement.

Active vegetation management is needed to maintain a diversity of wildlife in New England that has ebbed and flowed for thousands of years (DeGraaf and Yamasaki 2001). Land use in the last 250 years has clearly shaped the current condition, structure, and function of New England's forests. The forest composition in today's New England is a reflection of long-term climate change, elimination or reduction of specific species by introduced pathogens (e.g., chestnut blight), introduction of invasive weedy species, and historic and current land use practices (Foster 2000).

There is regional variation in natural and cultural influences on New England's ecosystems. Lorimer and White (2003) and others (e.g., DeGraaf and Yamasaki 2003) suggest managing within a natural range of variability rather than emulating an arbitrary point in time. Cogbill (2004) suggests that mimicking or accelerating natural disturbance regimes through forest management is difficult. The most perfect "mimic" is not to do anything. Managing on a 100-year rotation would be closest to a natural regime (Cogbill, 2004). Seymour et al. (2002) suggest that multi-aged silvicultural systems (e.g., single tree selection at 100-150 year rotations; group selection using 0.4-0.1 ha openings on 80-120 year rotations) fall within natural disturbance

patterns. The use of small (1-3 ha) patch cuts does not fit within natural disturbance patterns unless the rotation age is lengthened (>100 years) or some structural diversity is left in the patch cut (Seymour et al. 2002). Seymour et al. (2002) conclude that emulating infrequent, catastrophic disturbance has no ecological justification since those disturbances will occur anyway and early-successional habitat will be created during those events.

Litvaitis (2003) summarizes the differences between current and historic conditions. Today we have dense human settlements, loss of dominant plants such as chestnut, changes in ecosystem dynamics, restriction in the extent of beaver flowages, and loss of "stable" native shrubland habitats to development. These changes require flexibility and creativity in managing for New England's wildlife and their habitats.

The uncertainty about the future effects of climate change requires managers to use an adaptive management approach to maintain healthy ecosystems in light of that unpredictability (Inkley et al. 2004). Since management goals face such an uncertain future in the face of climate change, managers may need to focus on managing change itself. This may mean focusing on achieving a desired function, rather than a specific condition. Management will need to focus in the near-term on forestalling the effects of climate change, and in the long-term on increasing the resilience of ecosystems (Neilson, 2008).

Chapter 3. Resources of Concern

3.1 Resources of Concern

Resources of concern are the primary focus of the HMP. The Service is entrusted by Congress to conserve and protect migratory birds and fish, federally listed threatened and endangered species, inter-jurisdictional fishes, wetlands, and certain marine mammals (i.e., "trust species"). In addition to this System mission, each Refuge has one or more purposes for which it was established that guide its management goals and objectives. Further, refuges support other elements of biological diversity including invertebrates, rare plants, unique natural communities, and ecological processes that contribute to biological integrity and environmental health at the refuge, ecosystem, and broader scales (1999, 2003).

In collaboration with other Refuges in Northeast New England we developed matrices of animal species (and their habitats) that are of local, state, regional, or national conservation concern. The species were drawn from the following lists and plans:

- Partners in Flight Physiographic Area 28
- Bird Conservation Region 14
- Bird Conservation Plans (shorebird, waterbird, waterfowl, landbird)
- Federal Threatened and Endangered Species list
- State Threatened and Endangered Species lists
- Northeast States Nongame Technical Committee
- State Wildlife Action Plans

We looked to the following sources to develop a list of priority plant species and natural communities:

- State Natural Heritage Programs
- State Wildlife Action Plans
- The Nature Conservancy Ecoregion Plans

3.2 Biological Integrity, Diversity, and Environmental Health

The 1997 National Wildlife Refuge System Improvement Act states that in administering the System the USFWS shall "… ensure that the biological integrity, diversity, and environmental health of the System are maintained…" (USFWS 2003). The (2003) defines these terms as:

Biological Diversity	The variety of life and its processes, including the variety of living organisms, the genetic differences between them, and the communities and ecosystems in which they occur.
Biological Integrity	Biotic composition, structure, and functioning at genetic, organism, and community levels comparable with historic conditions, including the natural biological processes that shape genomes, organisms, and communities.
Environmental Health	Composition, structure, and functioning of soil, water, air, and other abiotic features comparable with historic conditions, including the natural abiotic processes that shape the environment.

In addition to providing habitat for trust species, refuges support other elements of biodiversity including invertebrates, rare plants, unique natural communities, and ecological processes (USFWS 1999). The HMP documents the process used by the Refuge to identify and prioritize trust resources and other elements of biodiversity for conservation action.

Where possible management on the Refuge restores or mimics natural ecosystem processes or functions and thereby maintains biological diversity and integrity and environmental health. Specific management actions are guided both by Refuge-specific goals and by landscape-scale conservation goals (e.g., BCR priorities). Given the continually changing environmental conditions (including climate change) and ecosystem patterns of the past and uncertainty about the future, management strategies should support mechanisms that allow species, genetic strains, and natural communities to evolve, rather than trying to maintain stability. As noted in section 2.7, ecologists recommend managing within a natural range of variability rather than emulating an arbitrary point in time.

Table 3.1, below, summarizes existing elements of biological integrity, diversity and environmental health (BIDEH) on the refuge.

Table 3.1. Summary of Habitats that Represent BIDEH for Umbagog National Wildlife Refuge.

Habitats (plant communities that Represent Existing BIDEH	**Population/Habitat Attributes**	**Natural Processes Responsible for These Conditions**	**Limiting Factors**
Fen & Flooded Meadow	Includes the following communities: medium fen, cattail marsh, seasonally flooded mixed graminoid meadow, eastern tussock sedge meadow, spikerush	Seasonal saturation (seasonally or temporarily flooded to semi-permanently flooded, due to surface water flow and/or groundwater	Water level and hydrology changed by Errol dam; Umbagog Lake level kept higher, longer due to dam, and management of dam

Habitats (plant communities that Represent Existing BIDEH	Population/Habitat Attributes	Natural Processes Responsible for These Conditions	Limiting Factors
	shallow emergent marsh, few-seeded sedge-leatherleaf fen. In most of of these communities grasses/sedges predominate; generally found around the wet edges of our peatlands. *Potential Conservation Species*: meagre sedge (S1), American black duck, ring-necked duck, common loon, pied-billed grebe, marshbirds, migrating waterfowl and shorebirds	flow; relatively nutrient/mineral and oxygen-rich flow (minerotrophic); acidic soils	for hydropower production; changes in precipitation/ hydrological regime / timing, resulting from climate change
Boreal Fen & Bog	Includes: leatherleaf poor fen, medium shrub fen, sub-boreal dwarf-shrub fen, circumneutral patterned fen, spruce-fir swamp, black spruce wooded bog, and black spruce-larch swamp. Various species of sphagnum and ericaceous shrubs are important community components. *Potential Conservation Species:* rare plant communities including Floating Island National Natural Landmark and the rare circumneutral-patterned fen, rare plants such as narrow-leaved cotton-grass (S1), rusty blackbird, palm warbler	Wet soils with restricted groundwater flow; less nutrient and less oxygen-rich; highly acidic conditions; absence of mineral soils; slow decomposition rates due to anaerobic and acid conditions leading to peat build-up.	Succession due to changes in amount of water flow, altered flood regimes, nutrient inputs, or sediment build-up, caused by natural processes, human disturbance (logging, road-building) and/or climate change
Northern White Cedar	Includes: northern white cedar-balsam fir peatland swamp, northern white cedar-black ash swamp, northern white cedar-boreal conifer mesic forest, northern white	This forested wetland type is generally found on saturated organic peat or muck soils with seasonal water fluctuations resulting from	Deer and/or moose browse; changes in hydrologic/ nutrient flow/timing; availability of 'nurse' logs for seedling regeneration;

Habitats (plant communities that Represent Existing BIDEH	**Population/Habitat Attributes**	**Natural Processes Responsible for These Conditions**	**Limiting Factors**
	cedar-peatland swamp, northern white cedar seepage forest, and northern white cedar-wooded fen. *Potential Conservation Species*: rare plant communities, including acidic northern white cedar swamp (S1), twayblade orchid; boreal bird species such as black-backed woodpecker, boreal chickadee, gray jay, bog lemmings	variation in upland runoff and/or seasonal groundwater flow (often seeps)	presence of canopy gaps for regeneration
Scrub-Shrub Wetlands	Includes: speckled alder peatland lagg, (speckled, green) alder shrubland, speckled alder swamp, and sweetgale mixed shrub thicket. Shrub cover (primarily speckled alder, sweetgale and leatherleaf) predominates; trees generally absent. *Potential Conservation Species:* American woodcock, Canada warbler, beaver	Seasonal flooding; beaver activity	Natural, human influenced (logging, dam controlled water level changes) or climate- influenced changes in hydrology
Open Water and Submerged Aquatic vegetation	Includes: open water of ponds, lakes, rivers, streams; floating –leaved and submerged aquatic vegetation, aquatic beds *Potential Conservation Species:* eastern brook trout, other native fish, bald eagle, osprey, common loon, other aquatic birds	Water quality, clarity/ light penetration, temperature nutrient loads; water depth and flow characteristics; timing/ seasonality of hydrologic regime	Introduced fish species; aquatic invasives, human disturbance, pollution from airborne and aquatic sources, land use practices (timber harvest, development) that influence sediment loads, water quality, shading; climate change that alters hydrologic and temperature regimes.

Habitats (plant communities that Represent Existing BIDEH	**Population/Habitat Attributes**	**Natural Processes Responsible for These Conditions**	**Limiting Factors**
Wooded Floodplain	Includes: red maple floodplain forest, red maple-balsam fir floodplain forest, white spruce-balsam fir berm woodland, red maple-tussock sedge floodplain woodland, black ash-mixed hardwoods, and red maple-black ash swamp. *Potential Conservation Species:* American black duck, cavity-nesting & brood-rearing waterfowl, northern parula, rusty blackbird, bald eagle, American woodcock	Primarily occur on mineral soils on periodically flooded bottomlands associated with river corridors. Flood disturbance, including flood frequency, duration and intensity, is the primary driver of the system. Underlying soils, geomorphology, and elevation also impact plant community composition and distribution	Land use practices such as timber harvest and development that affect erosion, sedimentation, hydrologic regime/ flooding interval; increase habitat fragmentation; dam management that alters water levels, flow and timing of flood events and sediment loads.
Lakeshore Pine-Hemlock	Includes: hemlock mesic forest, hemlock-hardwoods forest, hemlock-white pine-red spruce forest, red pine-white pine forest, and jack pine-blueberry-feathermoss forest *Potential Conservation Species:* bald eagle, osprey, jack pine	Associated with well-drained to excessively drained mineral (sandy) soils, or rocky exposed areas with shallow soils, subject to disturbance (jack pine); warmer microclimate (hemlock); primarily along lakeshores	Changes in lake water levels due to dam management; changes in disturbance regime with climate change; shoreline development.
Mixed spruce-fir/northern hardwood forest	Sub-habitat types: **Mixed woods**- Consists of red spruce-hardwood forest, successional spruce-fir forest, aspen-fir woodland **Spruce-fir**- Consists of lowland spruce fir forest, red spruce rocky summit, and black spruce-red spruce forest **Northern hardwood**- Consists of northern hardwood forest, semi-rich	Primary natural drivers of these upland forest systems are soils, aspect, elevation, moisture gradients, landscape position, and disturbance regimes. Mixed woods habitats are quite variable, but are generally persistent in areas with locally shallow soils or moister soils; generally on benches and plateaus, often	Natural succession; also logging history has converted some spruce-fir stands to mixed stands, and mixed stands to hardwood stands. It has also altered the natural 'tree gap' disturbance regime in favor of larger and more frequent disturbances; climate change will also tend to favor more southern species, over time.

Habitats (plant communities that Represent Existing BIDEH	Population/Habitat Attributes	Natural Processes Responsible for These Conditions	Limiting Factors
	northern hardwood forest, early successional aspen-birch forest/woodland, red maple-yellow birch early successional woodland, and paper birch talus woodland *Potential Conservation Species:* *Mixed woods*: blackburnian warbler, black-throated green warbler *Spruce-fir*: blackburnian warbler, black-throated green warbler *Northern hardwood*: Canada warbler, American woodcock; foraging habitat for blackburnian and black-throated green warblers	on northern and western hillslopes occasionally on steeper slopes; soils generally intermediate between poorer softwood soils and better hardwood soils. Spruce-fir habitats are often found in cold 'pockets', with wet soils, frequently adjacent to and grading into wetlands; often on shallow, acidic, nutrient- poor soils, at lower elevations and on summits of larger hills. Northern Hardwood habitat is usually found on lower to middle slopes on better soils, primarily on mesic loamy soils; often on east and southeast-facing slopes of hills	

3.3 Process for Determining Biological Priorities for a Refuge

A complete description of the Refuge's process for determining biological priorities may be found in the Umbagog National Wildlife Refuge Final Comprehensive Conservation Plan (CCP), Appendix H (USFWS, 2009). An overview of the process follows:

Freshwater Wetland Priorities

Most refuges have enabling legislation (i.e., one of their purposes) that includes "...the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions..." (Emergency Wetlands Resources Act 16 USC 3901b). Many refuges have freshwater wetlands as a high priority. The associated wetland focal species are described by

the respective waterfowl, wading bird, and shorebird national and regional plans and in the BCR 14 Plan. Range maps and refuge bird surveys were used to determine which of these regional focal species occur on the refuge.

Non-Bird Taxa Priorities

The Endangered Species Act (i.e., federal threatened and endangered species), state threatened and endangered species lists, State Natural Heritage Programs, and the Service's biodiversity policy provided guidance to the Refuge on protecting and managing native plants and animals that are at risk or for which the Refuge has a high responsibility given a species range and abundance. The priority species include freshwater mussels, brook trout and other native fish that are in decline, wide-ranging mammals such as lynx, rare or declining turtles, rare plant populations, and exemplary natural plant communities.

Upland Priorities

1. **Determined bird species of concern based on national and regional plans:**

   North American Landbird Conservation Plan
   Bird Conservation Regions 14
   Partner's In Flight Physiographic Areas 28

   Many of the species occur in all three plans. The PIF physiographic areas are the smallest unit of the planning regions. They provide a list of species and habitats that are more targeted to the sub-unit in which a refuge is located.

2. **Developed a species subset to reflect regional contribution to the NWR System:**

   PIF tiering was used to identify bird species and habitats in need of immediate management action in which the northeast has a high regional responsibility for the short and long term survival of the species. These included:

Tier 1A	High Continental Concern + High Regional Responsibility
Tier 2A	High Regional Concern
Tier 2B	High Regional Responsibility

3. **Analyzed the Breeding Bird Survey data to determine the level of contribution for a species provided by the landscape surrounding the Refuge:**

   a. Determined the level of relative abundance, scaled 0-4, for each species within each BBS block.

   b. Determined the species population trend for each BBS.

   c. Determined the species presence and relative abundance on the Refuge.
   Compared the species relative abundance and trend for the area that contains the refuge (and the surrounding area) with the species range, the other refuges, the planning unit, and Region 5 to determine the level of contribution based on BBS data and refuge data.

d. Overlapped species with similar habitat requirements to determine correlation among species in relationship to Refuge location.
An area of high concentration for a single species or group of species with similar habitat needs, indicated that the species is responding to current landscape conditions (increasing trend) or residual historical conditions (decreasing trend).

e. Selected priority habitats for the Refuge based on species concentration, population trend, and correlation with species of similar habitat needs.

4. Determined the site capabilities of Refuge lands

Site capability was determined by examining historical information (see CCP, (USFWS, 2009), Kuchler's Potential Natural Vegetation, and Ecological Land Units or soils. The goal is to manage the Refuge within a natural range of variability derived from the historical and current physiographic information that provides an indication of the type of vegetation best suited to grow in a given location.

5. Mapped current Refuge vegetation and surrounding landscape conditions

Vegetation types were derived from a mapping project carried out by the University of Vermont, Spatial Analysis Laboratory, using the National Vegetation Classification System (Map 2-2) (Rapp 2003). We supplemented those data with aerial photo flights and interpretation generated in 2004 by the James W. Sewall Company of Old Town, Maine. Natural communities were grouped into broader habitat types that provided a more practical scale for applying management actions. For lands acquired after 2004, broad vegetation categories were determined from NLCD and NWI data. A more complete description of our habitat types, as well as a cross-walk to other vegetation classification systems, may be found in the Umbagog National Wildlife Refuge Comprehensive Conservation Plan (CCP) (USFWS, 2009, Appendix G).

6. Determined desired future habitat conditions

When the Refuge fell within an area of high to medium concentration for a species or group of species with similar habitat needs, had the site capabilities to meet those habitat needs, and the current landscape conditions to allow for successful outcome of management actions, those species are identified as a high priority or focal species for that habitat on the Refuge. An emphasis is placed on that habitat in developing upland goals and objectives (see Chapter 4).

When the Refuge fell within an area of low concentration for a species or group of species with similar habitat needs, the Refuge evaluated the level of management required compared with the level of contribution the Refuge is making to the species (and habitat). This analysis is explained in the Umbagog NWR CCP, Appendix H, (USFWS, 2009).

In developing habitat goals and objectives (i.e., the "desired future condition" for priority habitats and focal species) in Chapter 4, the Refuge viewed itself within the context of the NWR System, current surrounding landscape, historic conditions, site capability and current vegetative condition, and feasibility. Feasibility is guided, in part by availability of Refuge resources and by any species-specific limiting factors. This approach should

enable us to be more responsive, and focus our management resources on communities and habitats more likely to be resilient in the face of climate change.

3.4 Priority Resources of Concern for Umbagog NWR

Using the above process the following habitats and associated focal species were identified as Refuge priorities.

Table 3.2 Priority Resources of Concern for Umbagog NWR	
High Management Priority Habitats	**Associated Focal Species**
Fen and flooded meadow	American black duck, ring-necked duck, common loon, pied-billed grebe, marshbirds, migrating waterfowl & shorebirds; brood-rearing wood duck & common goldeneye
Scrub-shrub wetland	American woodcock, Canada warbler
Open water & submerged aquatic vegetation	Native brook trout and other native fish, bald eagle, osprey, common loon, waterbirds
Wooded floodplain	American black duck , cavity-nesting and brood-rearing waterfowl, northern parula, rusty blackbird, bald eagle, American woodcock
Mixed spruce-fir/northern hardwood forest: mixed woods habitat type	blackburnian warbler, black-throated green warbler
Mixed spruce-fir/northern hardwood forest: spruce-fir habitat type	blackburnian warbler, black-throated green warbler
Moderate Management Priority Habitats	**Associated Focal Species**
Boreal fen and bog	rare plant communities (Floating Island National Natural Landmark; circumneutral patterned fen; peatlands)
Northern white cedar swamp	rare plant communities
Lakeshore pine-hemlock	bald eagle, osprey, jack pine
Mixed Spruce-fir/northern hardwood forest: northern hardwood habitat type	Canada warbler, American woodcock; foraging habitat for blackburnian and black-throated green warblers
Unique or rare communities	Vernal pools with obligate amphibians, talus slopes and cliffs, rare plant communities

Table 3.3. Key Habitat Structural Elements for Refuge Focal Species

Habitat	Refuge Focal Species	Habitat Structure	Other Benefiting Species
Fen and Flooded Meadow	American Black Duck	Nests within 145 meters of water. Food requirements include bulrush, arrowhead and wild rice. Key vegetation include sweetgale and conifers.	Pied-billed Grebe American Bittern Sora, other marshbirds Migrating shorebirds, waterfowl and wading birds Leopard Frog Mink Frog Beaver
	Ring-necked Duck	Prefer shallow freshwater wetland with stable water levels and abundant emergent and submerged or floating plants. Nests are typically on a floating mat of vegetation, but often in clumps of herbaceous or shrubby growth or on islands. Peak nesting is in mid-May.	
	Common Loon	Nesting habitat associated with lakes in spruce-fir or spruce-fir northern hardwood transition zones. Bodies of water with stable water levels and little or no human disturbance. Nests on the ground at water's edge, usually on sand, rocks or other firm substrate. Prefers small islands to shore.	
Boreal Fen and Bog	Floating Island National Natural Landmark	Appropriate hydrology and nutrient input to maintain diverse plant community.	Palm Warbler Rusty Blackbird Yellow-bellied Flycatcher
	Circumneutral Pattern Fen		
	Rare Peatland Plants		
Northern White Cedar Swamp	Rare plant communities	Grows on sites with shallow organic layers, relief to have flowing groundwater, well decomposed organic layers and neutral or slightly basic pH.	Boreal Chickadee Gray Jay Black-backed Woodpecker American three-toed woodpecker Spruce Grouse

Habitat	Refuge Focal Species	Habitat Structure	Other Benefiting Species
Shrub-Scrub Wetland	American Black Duck	Listed above	Alder Flycatcher Common Yellowthroat Eastern Kingbird Beaver
	Canada Warbler	Forest with dense understory, especially along streams, bogs, swamps or moist areas. Northern hardwoods with softwood understory. High percent shrub cover (70%), moderate canopy cover (64%) and few conifers in the canopy. First appear in clear-cuts 5 yrs. after harvest, become common after 15 yrs and remain abundant until next cutting cycle.	
	American Woodcock	Moist, rich soil dominated by dense shrub cover (75-90%); alder is ideal, young aspen and birch are suitable as feeding areas and daytime cover. In close proximity to one another: clearings, large openings for roosting, young second growth hardwood (15-30 yrs) for nesting and brood-rearing , and shrub foraging areas.	

Habitat	Refuge Focal Species	Habitat Structure	Other Benefiting Species
Wooded Floodplain	American Black Duck	Listed above.	Wood Duck Common Goldeneye Common Merganser Hooded Merganser Rusty Blackbird American Redstart Big Brown Bat Hoary Bat Little Brown Bat
	American Woodcock	Listed above	
	Cavity Nesting Waterfowl	Large trees with cavities for nesting, near clear, clean water with abundant aquatic invertebrates for feeding (Goldeneye); sandy, gravelly, or cobbled bottom with abundant small fish, less than 24 in. deep (hooded merganser); calm to rapid flowing water 1.5 to 6 ft. deep (common merganser); water with brushy	

Habitat	Refuge Focal Species	Habitat Structure	Other Benefiting Species
		overstory, stumps and fallen logs, cavities within 1.2 miles of water (wood duck).	Northern Long-eared Bat Vernal Pool Obligate species (Blue-spotted salamander, wood frog) Mink Frog
	Northern Parula	Mature, moist spruce woods along forest or forest/shore edge where mosslike lichens (*Usnea*) are found. Closed-canopy forests, variable conifer cover, and trees in the smaller size classes. Tolerates moderate levels of timber harvest, but absent from clear-cut and strip-cut areas. Sensitive to fragmentation, requires approximately 250 acres to sustain breeding populations.	
Open Water and Submerged Aquatic Vegetation	Native Brook Trout	Cool, well-oxygenated water; temperature not to exceed 68 degrees F for extended periods and oxygen levels remain at 5 ppm or greater. Vulnerable to the effects of predation and competition from other fishes, particularly in the first year or two of life. Spawn in flowing brooks or streams, shore spawning successful in some ponds with spring-water inflows in gravelly shallows.	Migrating Waterfowl Land-locked Salmon American Eel Lake Chub
	Common Loon	Listed above	
	Eagle and Osprey	Preferred feeding habitat: large bodies of water containing abundant fish resources (eagle); shallow-water areas of rivers, shoals of lakes where fish are close to the surface, abundant fish resources, preferably with little human disturbance (osprey)	

Habitat		Refuge Focal Species	Habitat Structure	Other Benefiting Species
Mixed Spruce-Fir/Northern Hardwood Forest	Mixed Woods Habitat Type	Blackburnian Warbler	Mature conifer forest of hemlock, pines, fir, spruce and mixed forests or moist forest where spruces are thickly draped with bearded lichen (Usnea). Strong affinity for saw-timber-size spruce and fir. Inhabits forests with high canopy cover (84%), variable coniferous cover and many trees in the smaller class sized >3 to <9.1 inches dbh. Nests high up in tree (usually spruce or hemlock), situated well away from the trunk or in a small fork near the top of the tree.	Black and White Warbler Purple Finch Wood Thrush Northern Goshawk Northern Long-eared Bat Ruffed Grouse
		Black-throated Green Warbler	Mid-to-mature mixed woodlands (especially hardwood-hemlock stands in northern hardwood-spruce), coniferous forest with large trees and larch bogs. Sensitive to logging activity, decline in heavily thinned forests. Large spruce for singing perches. Require large patches (>250 acres). Nest height 3 to 80 ft., typically 15 to 20 ft. usually on a horizontal or drooping branch in conifers and occasionally in hardwoods.	
	Spruce-fir Habitat Type	Blackburnian Warbler	Listed above.	Bay-breasted Warbler Cape May Warbler Boreal Chickadee Gray Jay Red Crossbill Spruce Grouse American Three-toed Woodpecker
		Black-throated Green Warbler	Listed above.	

Habitat		Refuge Focal Species	Habitat Structure	Other Benefiting Species
				Deer wintering areas Marten
	Northern Hardwood Habitat Type	Blackburnian Warbler	Foraging substrate of small limbs and bases of leaves.	Black-throated Blue Warbler Veery Wood Thrush Ovenbird
		Black-throated Green Warbler	Foraging substrate of paper birch. Occasional nesting.	
		Canada Warbler	Listed above.	
		American Woodcock	Listed above.	
Lakeshore Pine Hemlock		Bald Eagle and Osprey	Large trees adjacent to water for nesting, perching, and roosting, preferring areas with minimal human disturbance (eagle): elevated nest sites to 60 ft. preferring nest sites in or near water that provide good visibility, security and little human disturbance (osprey).	Migrating Landbirds Olive-sided Flycatcher Merlin
		Jack pine	Pioneer species found on dry , sandy, disturbed sites; shade intolerant	Seeds consumed by many small mammals

Chapter 4. Habitat Goals, Objectives, and Strategies

Goal 1. Manage open water and submerged aquatic vegetation and wetlands to benefit Federal trust species and other species of conservation concern.

Background

The Umbagog NWR includes a rich variety of wetland community types that support an array of habitat components—tree, shrub, herbaceous and aquatic plant species, and depth, chemistry and flow rate of water—providing benefits to a wide diversity of animal and plant species. The Magalloway River, Whaleback Ponds, Floating Island National Natural Landmark, Mountain Pond, Tidswell Point, and Dead Cambridge areas all contain extensive wetlands, some with rare species such as heart-leaved twayblade (*Listera cordata*) or bog sedge (*Carex exilis*). An unusual occurrence of a circumneutral patterned fen occurs at Tidswell Point (Rapp 2003). The Umbagog peatlands are among the state's largest and most diverse (Sperduto, 1999).

The Umbagog NWR is unique in the region for the diversity of waterfowl that breed here. The Umbagog Lake marshes and backwaters, forested and shrub wetlands, and adjacent forested and cutover uplands provide important nesting and brood-rearing habitat for waterfowl such as black duck (*Anas rubripes*), ring-necked duck (*Aythya collaris*), and cavity-nesters including, common goldeneye (*Bucephala clangula*), wood duck (*Aix sponsa*), common merganser (*Mergus merganser*), and hooded merganser (*Lophodytes cucullatus*). Blue-winged teal (*Anas discors*), green-winged teal (*Anas crecca*) and mallard (*Anas platyrhynchos*) also nest in the area.

In 2009, the refuge's Comprehensive Conservation Plan (CCP) was approved. The CCP expanded the refuge's acquisition boundary to a total of 76,939 acres (fee and easement). The CCP calls for managing any newly acquired lands in a way similar to management proposed for existing refuge lands and habitats (see Map 2-2 for location of habitat types on current refuge lands, and Umbagog CCP, (USFWS, 2009) for details on the objectives and strategies summarized in this chapter).

Climate change models indicate that over the course of the next century, wetland and open water habitats in the northeast are likely to be affected by predicted increases in temperature and changes in precipitation. Specific changes include: more flooding (especially winter flooding), earlier peak stream flows in the spring, longer summer low-flow periods, increased winter precipitation (primarily as rain), reduced snowpack and shortened snow season, later 'ice-in' and earlier 'ice-out' dates, increased frequency of droughts, and increased storm intensity (Frumhoff, et al. 2007). These changes may result not only in seasonal alterations in hydrology and groundwater flow, but in degradation of wetland and water quality.

Hydrologic change may impact the refuge's aquatic and wetland vegetation and peatlands. Impacts may include alteration of aquatic food webs, and changes in the wildlife species dependent upon them. Increasing aquatic temperatures and changes in stream flows may result in a decline in coldwater fish such as brook trout and other salmonids, by affecting their reproduction and spawning, susceptibility to disease, prey species, and migration opportunities. Many coldwater fish species are presently living near the limit of their thermal tolerance. Although warmwater species may expand their ranges, some warmwater fish may be unable to colonize fast-moving streams or circumvent human barriers, such as dams (Michaels et al. 1995). Many amphibian species are very sensitive to temperature and precipitation and are also likely to be affected by climate change. Amphibians dependent on vernal pools and other seasonal wetlands are particularly vulnerable (Corn, 2005). Aquatic and wetland dependent bird species in the northeast such as common loon, American bittern, and sora, are projected to experience declines tied to climate change (Frumhoff et al. 2007). Many of the refuge's management

strategies are designed to help mitigate the projected impacts of climate change as well as other stressors on aquatic and wetland ecosystems.

Objective 1.1 (Fen and Flooded Meadow*)*
Manage up to 689 acres of fen and flooded meadow on Service-owned lands, including those planned for acquisition from willing sellers within the approved refuge boundary. Provide nesting and brood rearing habitat for American black and ring-necked ducks, pied-billed grebe and other marsh birds, and brood rearing habitat for wood duck and common goldeneye. Also, manage undisturbed staging areas for migrating waterfowl and stopover areas for migrating shorebirds from late August through mid-October.

Maintenance of species associated with this habitat type requires providing a mosaic of different vegetative structures, water depths, and distribution of open water: vegetated patches. Attributes of fen and flooded meadow important to focal and associated species include:

- Extensive and persistent emergent vegetation including sedges and other graminoids, particularly along shorelines (pied-billed grebe, American bittern, waterfowl, spotted sandpiper)
- Substantial areas of ericaceous vegetation for cover (rails, pied-billed grebe)
- Diversity of herbaceous and floating-leaved and submerged aquatic vegetation that provide abundant seeds and tubers, and support abundant invertebrates and amphibians (waterfowl, spotted sandpiper, rails, great blue heron, American bittern)
- Interspersion of open water and vegetated areas, with a generally intermediate cover-to-water ratio (30-70%) (rails, waterfowl, pied-billed grebe, herons, sandpipers)
- Mosaic of different water depths, including some areas of shallow water (<15 cm (rails), 30-100 cm (pied- billed grebe))
- Relatively stable water levels during breeding season (common loon, harriers, ring-necked duck)

Rationale
The fen and flooded meadow habitat type encompasses medium fen, cattail marsh, seasonally flooded mixed graminoid meadow, eastern tussock sedge meadow, spikerush shallow emergent marsh, and few-seeded sedge-leatherleaf fen. The wetter edges of these natural communities are functioning as "emergent marsh" habitat for waterfowl and other marsh and water birds.
The refuge currently owns, or has approval to acquire an interest in, 689 acres of this habitat type. Our management emphasis over the next 15 years will be to identify the habitat attributes most important for sustaining the focal species identified in the objective statement, and enhancing, and/or restoring, those attributes. We describe some of those attributes in the species' discussions below.

Umbagog Lake is identified as one of three waterfowl focus areas in New Hampshire under the NAWMP (Atlantic Coast Joint Venture 2005). The Refuge supports the highest concentrations of nesting black ducks and ring-necked ducks in New Hampshire (USFWS 1991). The black duck is a species of concern in the NAWMP because of the historic decline in their population, with habitat loss an important contributing factor. The regional importance of Umbagog Lake to black duck was one of the reasons the refuge was established. Though black duck populations are stable or increasing, they are listed as highest priority for conservation in BCR14 (Dettmers, 2005).

Black duck pairs arrive in Maine by April with the peak hatch generally from June 1-10. They are quite intolerant of human disturbance even during brood stage; therefore, minimizing human disturbance from late May through June may be important. They are generalists in their nest site selection and locate well-concealed nests on the ground in uplands near beaver flowages, floodplains, alder-lined brooks, and other

wetlands. On the refuge, black duck and other waterfowl brood rearing habitat is in the "emergent marsh" around the edges of Leonard Marsh, and Harper's and Sweat Meadows, and the backwaters of the Magalloway and Dead Cambridge rivers. These shallow, permanent fens with abundant emergent vegetation, sedges, floating-leaved plants, pondweeds, and scrub-shrub vegetation rich in invertebrates, are favored brood rearing areas for waterfowl. Ducklings feed mostly on larvae of flies, caddisflies, mayflies, and other insects. Adult ducks eat the seeds of bur reed, sedges, pondweeds, and other aquatic plants as well as insects and other invertebrates (Longcore et al. 2000). In the expansion area, critical waterfowl areas planned for acquisitions include: the extension of the Magalloway River; Swift-Cambridge River; and Mollidgewock Brook.

Ring-necked ducks nest much closer to water than black ducks and are susceptible to water level changes. Therefore, the ring-necked duck may be an important indicator for the effects of water level fluctuations in Umbagog Lake. They build a nest usually on floating hummocks and islands in dense emergent vegetation, especially Carex sedges mixed with other herbaceous or woody plants. These ducks nest May through June, later than black ducks, with peak hatching occurring later in June. This diving duck forages in shallow water usually less than six feet deep. Their primary food sources are seeds and tubers of submerged and emergent plants and some aquatic invertebrates; the young depend entirely on aquatic invertebrates during their first two weeks (Bellrose 1976; Longcore, 2004).

The bathymetric study of the lake will help determine the effects of water level changes on waterfowl habitat. Water level changes that occur after mid-July would likely not have a significant effect on duck broods. Ducks with broods are not territorial and will keep moving around in the large inter-connected waterways of Umbagog Lake (Longcore, 2004).

Umbagog Lake is also an important migratory staging area for the waterfowl mentioned above as well as such species as scaup, scoters, and Canada geese. Many migrating waterfowl feed among the fen and flooded meadows on seeds and tubers of aquatic plants, while other species such as scoters, forage along the rocky shallow water areas of the lake.

Marsh birds using Leonard Marsh, Harper's Meadow, and Chewonki Marsh include Wilson's snipe, Virginia rail, American bittern, pied-billed grebe, and sora. The pied-billed grebe is listed as endangered in New Hampshire. The grebe typically builds a floating platform nest over shallow water attached to the stems of emergent vegetation. There is some indication that water depth (>10 inches to enable predator escape and nest construction) and density of emergent vegetation ($\geq$4 in^2 of stem basal area/yd^2) are important criteria and the pied-billed grebe may shift its nesting activity within and between nesting seasons in response to changes in water levels and availability of emergent vegetation cover (Muller and Storer 1999).

Our ability to benefit migratory shorebirds will depend on our ability to work with the holder of the FERC license for the Errol Project, FPLE, to affect water level management outside of June and July. Peak shorebird migration times for the Umbagog Lake area are mid-May to early June during spring, and late-August through mid-October for fall migration (Quinn, 2004). Shorebirds forage in exposed mudflats. Exposed mudflats occur irregularly in the fall depending on the lake levels, and occur most commonly where the Androscoggin River leaves Umbagog Lake in the Leonard Pond area. Inland freshwater wetlands and mudflats are thought to be particularly important for migrating spotted and solitary sandpipers. The most common shorebirds using the refuge are Wilson's snipe, spotted sandpiper, greater yellowlegs, and solitary sandpiper. The North Atlantic Regional Shorebird Plan lists greater yellowlegs as a high conservation priority (Clark and Niles 2000).

Management Strategies:

- Acquire up to 202 acres of fen and flooded meadow habitat still in private ownership within the approved refuge boundary, from willing sellers, and manage the fee land similar to current refuge lands under objective 1.1.
- Evaluate, and implement where appropriate, opportunities to expand wild rice and other vegetative food sources for migratory waterfowl
- If appropriate, initiate discussions with hydropower facility about modifying water level management to accommodate wildlife during breeding and migration seasons.
- Promote beaver activity to encourage maintenance and expansion of this habitat type

Monitoring Elements:

- Repeat the aquatic invertebrate survey at wetland edges every 5 years to monitor system health and waterfowl food resources
- Support research to determine the impacts of water level management on fen and flooded meadow habitat
- Conduct spring and fall migratory shorebird and waterfowl surveys as well as marsh bird, palm warbler, rusty blackbird surveys.
- Evaluate the impacts of various water levels on shorebirds, waterbirds, and marsh birds.
- Design and implement an expanded waterfowl, shorebird, marsh, and wading bird breeding survey program to include migration and brood surveys.
- Initiate study to determine the water level regime most beneficial to waterfowl at each important stage: breeding, brood rearing, and spring and fall migration.

Objective 1.2 (Boreal Fen and Bog)

Manage up to 4,086 acres of boreal fen and bog on Service-owned lands, including those planned for acquisition from willing sellers within the approved refuge boundary, to sustain the health and integrity, and uniqueness of the rare species and natural communities, such as the Floating Island National Natural Landmark, the circumneutral pattern fen, and other peatlands. Manage for the following attributes:

- Maintain/restore appropriate hydrologic (saturated soils, high water table) and nutrient regimes to maintain rare plant communities.
- Mosaic of vegetational structure to support nesting and foraging songbirds within habitat type or along periphery, including, where appropriate, scattered black spruce-larch with an undergrowth of low shrubs, ericaceous shrubs, sedges (palm warbler, rusty blackbird)

Rationale

The boreal fen and bog habitat types encompasses leatherleaf poor fen, medium shrub fen, sub-boreal dwarf-shrub fen, circumneutral patterned fen, black spruce wooded bog, black spruce-larch swamp, and spruce-fir swamp. "Peatlands" is another commonly used term to describe some of these plant communities. We recognize these plant communities as important components of the region's native biological diversity and seek to maintain the health of these areas in keeping with the Service's Biological Integrity, Diversity, and Environmental Health policy (601 FW 3) (see Umbagog CCP, (USFWS, 2009) for details on the objectives and strategies summarized below).

The refuge currently owns, or has approval to acquire an interest in, 4,086 acres of this habitat type. Our management emphasis over the next 15 years will be to complete an inventory of the unique and rare community types, and establish what measures of ecological health and integrity should be monitored over time.

On the western side of Umbagog Lake is a large peatland complex encompassing four areas: Leonard Marsh, Sweat Meadow, Harper's Meadow, and Chewonki Marsh. An 860-acre portion of the complex, known as "Floating Island," was designated as a NNL in 1982 (Nazaire 2003). We plan to work with the NPS to expand this boundary up to 2,181 acres. These areas and associated wetlands form one of the largest peatland complexes in New Hampshire and harbor a high diversity of vascular plants, mosses, and liverworts (Sperduto, 1999). The peatland complex is impacted by water level fluctuations in Umbagog Lake, although the impacts on community structure and species diversity and abundance are unknown (Nazaire 2003). In a study of a similar ecosystem in Sweden, Nilsson and Keddy (1988) found a direct correlation between the duration of flooding and species diversity and abundance, with long flood periods reducing plant diversity and abundance.

A rare fen of high regional significance, the circumneutral patterned fen, is found near the center of Tidswell Point. Most of this fen is on land owned by the State of New Hampshire as part of the Umbagog State Park, with a portion on the refuge. Only a few locations of this natural community type are known to occur in New England. A large, high quality northern white cedar swamp surrounds the fen (Sperduto, 2009).

This habitat type occupies the interface between open water, wetland, and upland forest habitats, and can be affected by management actions in adjacent habitat types. In general, activities that change the amount of water flow, alter flood regimes, nutrients, and/or sediment build-up will affect succession in this habitat type. Management of adjacent habitat types (including adjacent uplands) can therefore have a profound influence on the trajectory of boreal fen and bog habitats. Protecting and sustaining the floating bog, patterned fen, and other unique peatlands and their rare plant communities on the refuge requires increased efforts to identify and understand the factors that determine the occurrence and persistence of these peatland communities. We will monitor and manage the factors that effect the peatlands.

Many birds use peatland habitats for breeding, foraging, during migration, or in winter. These include palm warbler, rusty blackbird, black-backed woodpecker, yellow-rumped warbler, northern water thrush, and swamp sparrow, among others. Mink frog, a host of other amphibians, and a diverse suite of small mammals, including many shrew species and bog lemmings utilize this habitat as well. All of these species would benefit from the refuge's objective of conserving the boreal fen and bog habitat.

Boreal species, many of whom are at the southern limits of their range here, occur primarily in coniferous bog habitats on the refuge, (as well as in northern white cedar and spruce-fir). These bogs form islands of boreal habitat in a deciduous or mixed matrix, where more southern-ranging species predominate. In the face of climate change, these bogs may help to maintain populations of boreal species in regions otherwise dominated by more temperate species (Calme et al. 2002).

Management Strategies:

- Acquire up to 2,851 acres of boreal fen and bog still in private ownership within the approved refuge boundary, from willing sellers, and manage the fee land similar to current refuge lands under objective 1.2.
- Work with the NHNHB and Maine Natural Areas Program (MNAP), and National Park Service (NPS) to identify and refine monitoring and management criteria for the FINNL and the other unique wetlands
- Develop a proposal to NPS to modify the current natural landmark boundary to more accurately encompass the natural system.
- Establish buffer zones around these sensitive natural communities based on best management practices published by both states; evaluate their effectiveness and appropriateness in protecting these habitats over the long-term.

Monitoring Elements:

- Conduct a hydro-geologic study of groundwater and nutrient flow that are maintaining refuge peatlands. Address issues or threats as necessary.
- Establish baseline inventory and permanent markers in this habitat type. Revisit and photograph these plots every 5 years
- Evaluate implications from management on habitat requirements of birds of conservation concern.
- Work closely with State Non-game and Natural Heritage programs to identify and monitor rare species occurrences in this habitat type.
- Conduct a comprehensive inventory of the Floating Island National Natural Landmark (FINNL) to better define criteria for monitoring and managing its diversity and integrity over the long-term

Objective 1.3 (Northern White Cedar)
Manage up to 1,031 acres of northern white cedar on Service-owned lands, including those planned for acquisition from willing sellers within the approved refuge boundary, to sustain the health and diversity of natural and rare ecological communities in the Upper Androscoggin watershed.
Manage for the following attributes:

- Appropriate hydrologic and nutrient regime (strong flow of moderately mineral-rich soil water)
- Presence of decaying 'nurse logs' and canopy gaps that help promote regeneration and seedling survival
- Partial over-story shade to reduce drought and competition
- Limited browsing pressure by herbivores

Rationale
Northern white cedar habitat encompasses a suite of natural communities, all dominated by northern white cedar. Northern white cedar is a boreal species that occurs as far south as Carroll and Grafton counties in New Hampshire. NHNHB considers northern white cedar swamps a "signature community" of the north woods and hence an important component of the region's biodiversity (Sperduto and Engstrom 1998). We recognize these plant communities as important components of the region's native biological diversity and seek to maintain the health of these areas in keeping with the Service's Biological Integrity, Diversity, and Environmental Health policy (601 FW 3) (see Umbagog CCP, (USFWS, 2009) for details on the objectives and strategies summarized below).

The refuge currently owns, or has approval to acquire an interest in, 1,031 acres of this habitat type. Our management emphasis over the next 15 years will primarily be to complete an inventory of this habitat type, and establish what measures of ecological health and integrity should be monitored over time.

The largest (80-100 acres) northern white cedar swamp in New Hampshire surrounds the Whaleback Ponds and extends toward the Magalloway River. This wetland basin is within the refuge acquisition boundary but only a portion is currently under Service ownership (Sperduto,1999).

Several northern bird species use this habitat type year-round including boreal chickadee, gray jay, black-backed woodpecker, spruce grouse, and more rarely, American three-toed woodpecker, (a New Hampshire threatened species). White-tailed deer find cover and forage in northern white cedar

stands. Ten species of amphibians and 7 species of small mammals are known to occur in this habitat type on the refuge, and will directly benefit from our objective to maintain it.

Management Strategies:

- Acquire up to 202 acres of northern white-cedar still in private ownership within the approved refuge boundary, from willing sellers, and manage the fee lands similar to current refuge lands under objective 1.3.
- Establish buffer zones to protect these sensitive natural communities using best management practices developed by states; evaluate their effectiveness and appropriateness in protecting this habitat type over the long-term.
- In cedar-growing areas, minimize competition from balsam fir and hardwoods resulting from disturbance or management actions.
- Restore up to 150 acres over 15 years of northern white cedar in areas where past land use practices have converted it to another habitat type; consider winter cutting and other accepted silvicultural practices, including thinning-release, that would promote cedar stands.
- Manage to provide connectivity between this habitat type and coniferous bog and spruce-fir habitats, to increase patch size and provide movement corridors for boreal species.

Monitoring Elements:

- Inventory small mammal and amphibians using this habitat type
- Work closely with State Non-game and Natural Heritage programs to conduct more detailed surveys of rare plant and animal occurrences in, and the overall condition, of these natural communities.
- Evaluate and monitor regeneration of northern white cedar including potential impacts from deer, snowshoe hare, and moose browsing.
- Evaluate the habitat requirements of boreal species utilizing this habitat type, such as black backed woodpecker, and if appropriate, manage to enhance habitat components for these species.
- Evaluate land use changes and management actions (e.g., timber harvest) and how they might affect the hydrology of this habitat type.

Objective 1.4 (Scrub-Shrub Wetland)

Manage up to 1,807 acres of scrub-shrub wetland on Service-owned lands, including those planned for acquisition from willing sellers within the approved refuge boundary, as foraging and brood habitat for American woodcock, and to provide nesting and migratory habitat for birds of conservation concern, such as Canada warbler. Attributes of scrub-shrub wetlands of importance to refuge focal species include:

- Dense shrub cover (75-90%) (especially <20 year old alder), with a well-developed litter layer, in proximity (within ~ 500m) to clearings and young (<30 yrs) hardwood areas (especially aspen, birch with 50-60% overstory cover, and shrub understory) (American woodcock)
- Well-developed tall deciduous (especially alder, willow) shrub layer (> 70% cover) near streams/wetlands (Canada warbler)

Rationale

Scrub-shrub wetland encompasses speckled alder peatland lagg, speckled and/ or green alder shrubland, speckled alder swamp, and sweetgale mixed shrub thicket. The refuge currently owns, or has approval to acquire an interest in, 1,807 acres of this habitat type. Our management emphasis over the next 15 years will be to identify the habitat attributes most important for sustaining the focal species identified in the

objective statement, and creating and/or enhancing those attributes, especially in woodcock focus areas (see Map 4-4, for locations of woodcock focus areas). We describe some of those attributes in the species' discussion below (see Umbagog CCP, (USFWS, 2009) for details on the objectives and strategies summarized below).

The Service developed the American Woodcock Management Plan in 1990 to help stem the decline in American woodcock (USFWS 1990). Long-term trends show a decline of –1.3% per year from 1993-2003 and –2.3% per year from 1968-2003 in the eastern United States. Between 2002 and 2003, Maine reported an increase in the breeding population, yet the overall trend in Maine since 1968 is still negative. New Hampshire showed no significant increase from 2002 to 2003, but it is the only eastern region state showing an increase from 1968 to 2003. Recruitment rates (number of immature birds per adult female) in recent years are 18% below the long-term regional average. The major causes for these declines are thought to be loss and degradation of habitat on the breeding and wintering grounds, resulting from forest succession and land use changes (Kelley 2003). The 2005 Maine CWCS identifies habitat conservation, and additional surveys and monitoring, as the two highest priorities in the state for conserving woodcock populations (MDIFW 2005).

Functional foraging habitat for woodcock occurs on moist, rich soil dominated by dense shrub cover (75-90%); alder is ideal, although young aspen and birch are also suitable as feeding areas and daytime (diurnal) cover. Woodcock require several different habitat conditions that must be in close proximity to one another. These include clearings for courtship (singing grounds), large openings for night roosting, young second growth hardwoods (15-30 years) for nesting and brood-rearing, and functional foraging areas (Sepik et al. 1981; Keppie and Whiting 1994).

The Canada warbler is declining across much of its range and is listed as highest priority in BCR 14 (Dettmers, 2005). PIF has a goal of increasing the Canada warbler continental population by 50% (Rich et al. 2004). It breeds in a range of habitat types including deciduous forested swamps, cool, moist, mature forest or streams and swamps with dense undergrowth, streamside thickets, and cedar bogs (Conway 1999). Although shrub-scrub is an important habitat component over some of its range, it may be of lesser importance in the northeast. It nests on or near the ground, generally near water. Suitable habitat often has a layer of moss and an uneven forest floor; however, they may be less common in shrub wetlands (Conway 1999). On the White Mountain National Forest in New Hampshire and Maine they occur in northern hardwoods with a softwood understory (DeGraaf and Yamasaki 2001). In central Maine, Collins (1983) found the Canada warbler in forests with a high percent shrub cover (70%), moderate canopy cover (64%), and minor component of conifers in the canopy. Hagan and Grove (1999) suggest the species is likely adapted to natural tree fall gaps, hence their positive response to forest management that creates dense deciduous understory with some overstory remaining. Canada warbler will also benefit from the management in mixed woods and northern hardwoods (see objective 3.1). The 2005 Maine CWCS identifies habitat conservation and research as the two highest priorities in the state for conserving Canada warbler populations (MDIFW 2005).

Other birds that nest in scrub-shrub habitat include swamp and song sparrows, common yellowthroat, yellow warbler, and alder flycatcher.

Beaver can be ecologically important to creating and maintaining scrub-shrub and other wetlands environments that also provide important habitat for woodcock and Canada warbler, other focal species such as black duck and wood duck, and culturally important species such as moose. Our plan to analyze opportunities for furbearer management will consider the impacts of managing local beaver populations to improve habitat and meet refuge goals. Beaver occupy small to large slowly flowing, wooded streams, rivers, or lakes and rarely occur in fast-moving waters. Howard and Larson (1985) described the best beaver habitat as occurring on relatively wide streams with low gradient on soil with poor drainage.

Nearby food sources are also important including the roots and tubers of aquatic vegetation for summer diet and the bark of deciduous trees for fall and winter caching (DeGraaf and Yamasaki 2001). Stream gradients less than 3 percent are optimal, while narrow, steep valleys are less suitable.

Management Strategies:

- *Acquire* up to 1,125 acres of scrub-shrub wetlands still in private ownership within the approved refuge boundary, from willing sellers, and manage the fee lands similar to current refuge lands under objective 1.4.
- Protect, buffer, and promote large patches of contiguous riparian/streamside shub habitat for Canada warbler. Riparian buffers should extend at least 100 m from wetland or shoreline edge in order to include typical Canada warbler territory (Lambert and Faccio, 2005)
- In woodcock focus areas (see Map 4-4) manage scrub-shrub habitat in proximity to upland nesting areas. Create and maintain alder in suitable age/size class to maintain quality foraging and brood areas. Alder would be maintained on approximately 20-year rotations.
- Manage concurrently for Canada warbler in woodcock focus areas.

Monitoring Elements:

- Implement vernal pool, small mammal and amphibian surveys
- Continue and expand woodcock and Canada warbler surveys in this habitat type.

Objective 1.5 (Open Water and Submerged Aquatic Vegetation (S.A.V.)

In partnership with the States of Maine and New Hampshire, and the holder of the FERC license for the Errol Project manage up to 5,903 acres of open water on Service-owned lands, including those planned for acquisition from willing sellers within the approved refuge boundary, to maintain floating-leaved and submerged aquatic vegetation (SAV) and native fish such as brook trout. Also, manage waters to provide loafing and foraging areas for water birds, and to maintain high water quality to benefit other native vertebrate and invertebrate aquatic life (see Umbagog CCP, (USFWS, 2009)) for details). Desirable attributes of open water and S.A.V. habitat include:

- In lentic waters, a diversity of floating-leaved and submerged aquatic vegetation, including pondweeds, etc., that provide seeds and tubers, and support abundant invertebrates (fish, waterfowl and other migratory birds, pond amphibians)
- Absence of invasive plant species
- Continued absence of non-native fish in of bodies of water currently lacking non-natives
- Excellent water quality, including low stream/river sediment loads/turbidity
- Appropriate hydrologic regime and flow and water levels in rivers, tributary streams, and lakes (fish, including trout, common loon)
- Streams/rivers with stable flow and temperature regimes (coldwater fish, including trout, amphibians)
- Streams/rivers with stable, shaded, well-vegetated banks (coldwater fish, including trout, amphibians)
- Cold stream temperatures with temperatures generally < 65 degrees F (coldwater fish, including trout).
- Abundant instream cover (fish, amphibians)
- Good habitat connectivity (especially between areas of good trout habitat)

Rationale

The refuge currently owns, or has approval to acquire an interest in, 5,903 acres of this habitat type. The refuge's open waters encompass the rivers and backwaters, small ponds, and the portion of Umbagog Lake that extends from the current shoreline to the original, pre-1851 shoreline, including the zone of

floating-leaved and submerged aquatic vegetation. These open waters provide loafing areas for many birds and harbor important plant and other food resources below the surface. It is primarily on the fee title lands that we plan to conduct active management. Our management emphasis over the next 15 years will be to inventory and map the extent of SAV and mussel beds, and establish parameters, and implement a program, for monitoring water quality and the effects of water-level fluctuations on resources of concern.

Umbagog Lake has some unique features, perhaps related to its extensive shallow areas. The average depth of the lake is 15 feet. The lake has vast mussel beds that extend through much of the lake, at least on the New Hampshire side. The enormous collective filtering capacity of this community may contribute much to the high water clarity of the system. More study is needed to understand how the mussels affect the rest of the Umbagog Lake food web and how water level fluctuations affect the mussels (Haney, 2005).

Submerged aquatic vegetation (SAV), with their flexible stems and leaves, are rooted in the sediment and completely covered by water. These plants produce oxygen, filter and trap sediments, absorb nutrients, and provide food and shelter for fish and wildlife. Plants such as pondweeds and wild celery produce seeds and tubers critical to foraging waterfowl. SAVs host many aquatic invertebrates that are, in turn, food for waterfowl and their broods. The distribution of these plants in the lake is affected by water depth, water clarity, and sediment type. SAVs typically occur on muddy or soft sediments rather than on sand or gravel sediments (Stevenson et al. 1979, Krischik et al. 2005). Different water levels on Umbagog Lake affect the extent of ice scouring and freezing of the lake bottom and consequently the distribution of SAVs.

The Magalloway River and Umbagog Lake are important wintering habitat for native brook trout from the Diamond River watershed (Timmins, 2004) and Rapid River (Boucher, 2005). MDIFW is concerned about potential recruitment of smallmouth bass into the Rapid River and the Cambridge River systems and the bass dominating critical habitat and food resources to the detriment of "an extraordinary brook trout resource" (Boucher 2005). Smallmouth bass were illegally introduced into Umbagog Lake around 1985. Prior to this release, the major fishery in the lake was a cold water fishery around the mouth of the Rapid River and warm water fishery for pickerel and yellow perch.

In addition to potential impacts to brook trout, there are indications that the number and behavior of anglers has changed on Umbagog Lake with the arrival of bass. Bass anglers fish more intensively than other anglers and tend to fish in shallower water, close to shore, and spend more time in one spot. The impacts to this increased fishing pressure on loons and other wildlife is unknown (Bonney, 2002).

Management Strategies:

- Determine, in cooperation with state partners, the holder of the FERC license for Errol Project, and the Umbagog Working Group, how best to implement the Eastern Brook Trout Joint Venture goals and objectives in this area
- Evaluate littoral zone sediments where submerged aquatic vegetation is sparse or non-existent, and re-establish vegetation where appropriate to enhance or improve food resources for waterfowl
- Evaluate the potential use of fish barriers to prevent non-native fish species from becoming established in water bodies surrounding Umbagog Lake;
- Acquire up to an estimated 870 acres of open water habitat within the approved refuge boundary and manage the fee lands similar to current refuge lands, as described in objective 1.5.
- Evaluate point and non-point sources of pollution affecting refuge lands and work with State, private and local entities to improve water quality
- Follow best riparian management practices to maintain stream/ river water quality, appropriate temperatures, hydrologic regimes, and coarse woody debris.

- Insure that roads, culverts, and other structures do not fragment fish habitat (especially eastern brook trout habitat), by acting as fish barriers

Monitoring Elements:

- Initiate mapping project to determine distribution of submerged aquatic vegetation – species, density, and size of beds.
- Initiate mapping and monitoring program to evaluate native mussel beds; survey lake and associated rivers for rare and invasive species.
- Monitor water quality, chemistry, and water levels for potential effects on aquatic vegetation, fish, and waterfowl.
- Inventory macro-invertebrates and fisheries resources.

Objective 1.6 (Common Loon)

Within 15 years of CCP completion, and cooperating with state partners, and the holder of the FERC license for the Errol Project (currently FPLE), as appropriate, conserve and manage common loon territories to support a 5-year annual average of 14 nesting pairs on Umbagog Lake and its tributaries, and 4 additional pairs within the expansion area, and achieve a 5-year average annual productivity of 0.5 chicks per nesting pair. Map 4-1 shows the location of recently active common loon territories on Umbagog Lake and vicinity. Management activities will be focused in fen and flooded meadow, floodplain and lakeshore, and open water and submerged aquatic vegetation habitats (see Umbagog CCP, (USFWS, 2009) for details on the objectives and strategies summarized below). Attributes important to common loons include:

- Stable water levels during breeding season with a goal of limiting water level changes to no more than a 6 in. increase or a 1 ft. decrease for most of the egg-laying and incubation period.
- Good water quality with low turbidity
- Reduced availability of lead sinkers, shot, and discarded fishing line in environment
- Availability of appropriate nest sites that provide protection from predators and are secluded from disturbance
- Abundant prey (fish) resources

Rationale

Umbagog Lake and its associated rivers and backwaters are important breeding areas for the common loon in the Northeastern United States. This refuge is one of only 3 in the Refuge System in the lower 48 states that support breeding common loons. The common loon was also one of the key species specifically identified for conservation at the time of refuge establishment. The BCR 14 plan lists the common loon as a species of moderate conservation concern.

Regional threats to common loon include habitat loss due to shoreline development, water level fluctuations, human disturbance (recreational pressures), environmental contaminants, oil spills, lake acidification, mercury poisoning, and lead poisoning among other threats. The proposed Lowest Observed Adverse Effect Level (LOAEL) for mercury in adult loon blood is 3.0 ug/g (Evers et al. 2004). Because blood mercury levels from adult loons sampled from Umbagog Lake during 1994-2004 have never reached this proposed effect level, mercury does not appear to be a risk factor to adult loons in this system. Lead fishing tackle does pose a significant threat to loons. From 2000-2004, six loon carcasses found on Umbagog Lake were submitted to Tufts University School of Veterinary Medicine to determine the cause of death. All six (100%) were attributed to lead poisoning (Mark Pokras, Tufts University, unpublished data).

The Service and cooperating partners monitor and manage activities on Umbagog Lake to benefit loons. They work annually with the holder of the FERC license for the Errol Project, currently FPLE, who manages water levels, and by closing nesting areas, and installing educational signs. In spite of these management activities, the Loon Preservation Committee (LPC) reported that the Umbagog Lake loon population declined from 31 territorial pairs in 2000 to 15 territorial pairs in 2002 (Taylor and Rubin 2002).

The majority of loon nests on Umbagog Lake are established from mid-May to mid-June with hatching dates from mid-June to late July. Nest site selection is often opportunistic with loons using island and mainland marshes, muskrat feeding mounds, floating bogs, and logs. Loons also readily accept floating platforms (McIntyre and Barr 1997). Common loons are strongly territorial and the territory size they will defend is highly variable depending on lake size, suitable nesting sites and land features that provide privacy from other pairs (Lang and Lynch 1996). Umbagog Lake's large size and prevalence of coves and islands offers many potentially suitable territories for common loons.

Using summary data from LPC reports from 1991 to 2005, the number of nesting pairs were analyzed in 5 year intervals to develop a target number of nesting pairs of common loons. From 1991-1995, the average number of nesting pairs was 17.4 + 3.44, from 1996-2000, the number was 18.4 + 2.30 and from 2001-2005, the number was 14.0 + 2.92. The historical average from 1976 to present (14 pairs) is reflected in the most current 5 year average. This number of nesting attempts by common loons also reflects current conditions with confounding variables including the presence of 4 nesting pairs of eagles. The refuge and cooperating partners will work to keep the number of nesting pairs at the approximate historical average of 14 pairs. The refuge and cooperating partners will also work toward increasing production of those 14 pairs to an average of 0.5 chicks per pair based on the rate of 0.48 chicks fledged per pair for a self-sustaining population (Evers et al. 2004). This objective is not intended to maximize the number of common loons in the area, but to achieve a level which reduces negative interactions between common loons and between common loons and other waterfowl. The four additional pairs within the expansion area include territories on: 1) Sturtevant Pond, 2) B Pond, 3) C Pond and 4) Pond in the River.

Management Strategies:

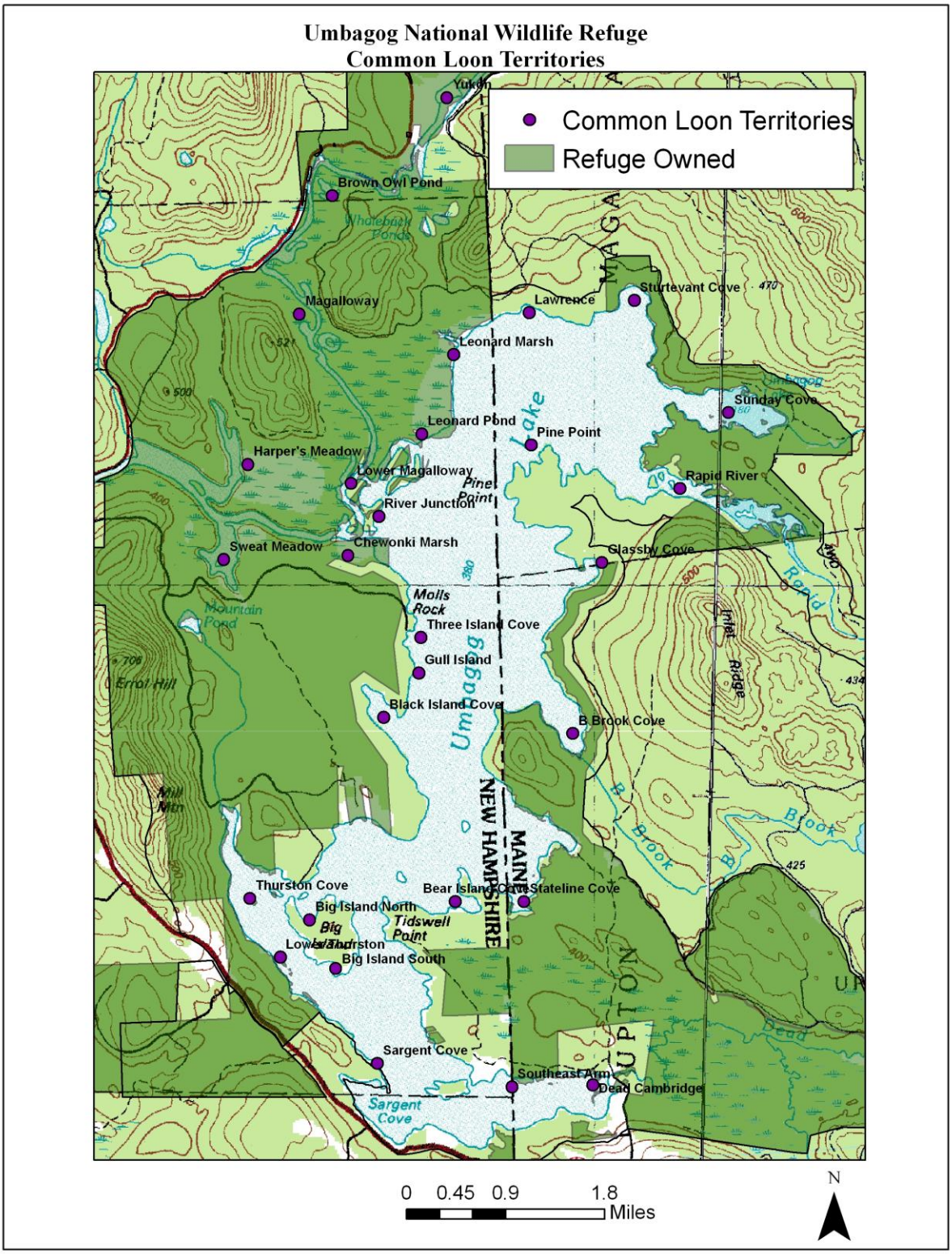
- Participate in annual meetings with FERC licensee or representative to advise on lake water levels to benefit nesting loons, within the conditions of the FERC license and Article 27
- Protect active loon nests in spring and summer from predators and human disturbance using outreach and visitor contact, buoy lines, restricted access, and other tools as warranted
- Evaluate the need for predator control around common loon sites; consider predator control measures targeted at individual animals
- As studies are completed on Umbagog Lake, validate the loon nesting and territorial carrying capacities, and further determine whether 14 nesting loon pairs on the lake, and 4 nesting pairs in the expansion area, remain appropriate targets for these areas
- Introduce floating loon rafts with predator guards in established, previously successful territories where nest failures have occurred in 3 successive years. Retain rafts in territories for a minimum of 3 years, in order to establish efficacy.

Monitoring Elements:

- Develop and maintain an Umbagog Lake loon dataset in partnership with NHFG, MDIFW, and private conservation organizations
- Monitor loon populations in partnership with the states, conservation organizations, and the holder of the FERC license for the Errol Project
- Support research to determine causes and implications for decline in number of loon territories on Umbagog Lake

- Monitor angler use and map locations of fishing pressure and other recreational users, in relation to common loon territories and other breeding wildlife
- Develop and implement a study to evaluate interactions of loon with waterfowl during the breeding season; specifically, evaluate how waterfowl interact at high loon densities.
- Develop and implement a study to examine interactions between loons and other piscivores (eagles, osprey, etc.), including competition for food and nest sites

Map 4-1. Common Loon Territories.



Goal 2. Manage floodplain and lakeshore habitats to benefit Federal trust species and other species of conservation concern.

Background

Riparian ecosystems are areas adjacent to water bodies and non-forested wetlands and are often areas with high species richness with dynamic and complex biophysical processes. Floodplain and lakeshore forests are part of the riparian ecosystem. The Umbagog NWR floodplain and lakeshore habitats are important for many wildlife species of concern including nesting and foraging waterfowl, bald eagle (*Haliaeetus leucocephalus*), osprey (*Pandion haliaetus*), and many songbirds. Riparian areas provide important structural components including large nest trees for eagles and ospreys and cavity trees for goldeneyes, wood ducks, and songbirds. The New Hampshire Natural Heritage Bureau (NHNHB) describes the Magalloway River floodplain as a rare floodplain forest community type. Riparian areas help control erosion and sediment loading into the lake and its tributaries. Without forested shorelines, stream banks are more susceptible to erosion. A majority of the camp leases are here and most of the boat traffic occurs here, presenting concerns about water quality, erosion, and wildlife disturbance.

Most of the vernal pools on the Refuge are imbedded within these floodplain and riparian habitats. A vernal pool is a small water body lacking a permanent above ground outlet. In the northeast, vernal pools fill with winter snow melt and spring and autumn rains, typically drying by mid to late summer or earlier in drought years. The duration of the presence of water in a vernal pool is known as the hydroperiod, varying depending on the pool and the year. A vernal pool, because of its periodic drying, does not support breeding populations of fish. Vernal pools on the Refuge provide essential habitat for several obligate amphibian species including blue-spotted (*Ambystoma laterale*) and spotted salamanders (*A. maculatum*) and wood frog (*Rana sylvatica*), contributing to Refuge biodiversity. Maintaining vernal pools with a range of hydroperiods is important in sustaining vernal pool biodiversity.

Under most climate change models for the northeast, temperatures will increase and precipitation will become more variable, including changes in amount, timing, and intensity. This is likely to result in alteration of the hydroperiod of many vernal pools, causing them to dry up earlier in the year and remain dry for a longer time period. Altered hydroperiods may result in less successful reproduction by vernal pool amphibians. Drying may also increase isolation and reduce movement between successful pools (Brooks, 2004). Restoration and protection of floodplain and vernal pool habitat will help mitigate the effects of these changes.

Restoration of developed floodplain and lakeshore riparian areas involves removing cabins and other structures when funding and staffing allows. In 1996, the Refuge started taking over cabin leases on the land acquired from the James River, Boise Cascade, and Mead Paper Companies. The leases include certain conditions, such as (1) the camps must be maintained in a manner compatible with the purposes of the Refuge and produce the least amount of environmental disturbance, (2) no new permits will be issued for construction of new camps on the properties, and (3) transfer of lease ownership outside of the immediate family can only occur during the first thirty five years of the lease agreement. Most of these structures were built as summer fishing camps or seasonal cottages, but some have become year-round cottages. All the camp leases expire in 50 years from date of acquisition (see Umbagog CCP, USFWS, 2009) for details on the objectives and strategies summarized below).

Objective 2.1 (Wooded Floodplain)

Manage up to 1,429 acres of wooded floodplain on Service-owned lands, including those planned for acquisition from willing sellers within the approved refuge boundary, to provide habitat for nesting cavity-dependent waterfowl and other priority bird species of regional conservation concern, including northern parula and rusty blackbird. In addition, manage perching areas for bald eagle, and brood foraging

areas for American black duck and other waterfowl. Also, where this habitat type overlays woodcock focus areas, manage for feeding and nesting American woodcock. Desirable attributes of this habitat type for focal species and associated communities include:

- Well vegetated shorelines to reduce erosion and sedimentation
- Large, unfragmented blocks of mature (>40 yrs) forested habitat with a well-developed overstory (northern parula),
- Well-developed shrub understory (Canada warbler, woodcock)
- >75% canopy cover of trees >30 ft to shade, protect and provide connectivity between vernal pool amphibian habitats
- Suitable forest floor environment, including uncompacted deep litter and coarse woody debris (amphibians, small mammals)
- Large diameter trees (>18 in. d.b.h.) (cavity-nesting waterfowl, osprey, eagles)
- Large diameter snags (cavity nesting waterfowl)
- Super-canopy white pines (osprey, eagles)
- Appropriate hydrologic regime to maintain rare Magalloway floodplain community type and vernal pool amphibians.
- Quiet well-vegetated backwater areas that provide foraging and brood-rearing areas in proximity to nest sites (American black duck and other waterfowl)

Rationale

Wooded floodplain habitat on the refuge includes the following National Vegetation Classification System (NVCS) associations: red maple floodplain forest, red maple-balsam fir floodplain forest, white spruce-balsam fir berm woodland, red maple-tussock sedge floodplain woodland, black ash-mixed hardwoods swamp, and red maple-black ash swamp (see appendix G in the Umbagog NWR CCP (USFWS, 2009), for a cross-walk between refuge habitat types and other vegetation classification systems).

This habitat type, which constitutes approximately 5% of refuge acres, contributes significantly to the wildlife diversity known on the refuge (see Map 2-2 for the distribution of this habitat type on current refuge lands). For example, we have detected over 75 bird species from point locations in this habitat type during our breeding bird surveys.

The Magalloway River floodplain, ranked as an S2 (imperiled) community by NHNHB, and approximately 245 acres in size, offers quality habitat for waterfowl, providing the combination of large cavity nesting trees and river bottomland areas with submerged and floating leaf aquatic plants and abundant substrate for invertebrates. Common goldeneye, wood duck, and hooded and common mergansers nest in cavities in live trees with a diameter at breast height (d.b.h.) of 18 inches or more (Tubbs et al. 1986).

The rusty blackbird, a watchlist species for BCR 14 and PIF 28 bird conservation planning areas, nests in riparian areas, boreal wooded wetlands, and beaver flowages (DeGraaf and Yamasaki 2001; Rich et al. 2004). According to the species profile in the 2005 NH WAP, this species has declined dramatically; BBS results from 1996-2001 indicate a 10.7% decline (New Hampshire Fish and Game Department, 2005).

We have documented rusty blackbird breeding in the Magalloway River floodplain. It builds a nest near streams, ponds, bogs, and fens with a conifer component, usually less than 10 feet above the ground in thick foliage near the trunk of a young spruce or fir or in a shrub thicket. It will also utilize the spruce-fir and mixed woods habitat types between 1000 ft to 4,000 ft in elevation in refuge uplands. During migration rusty blackbirds congregate in flocks in wooded swamps (DeGraaf and Yamasaki 2001) and

migrating flocks are documented for Umbagog Lake (Brewster 1937), although they may be less common now (Richards 1994). The rusty blackbird shows some aversion to clearcutting that creates suitable habitat for competitors including red-winged blackbird and common grackle (Dettmers, 2005). Some disturbance (e.g., windthrow, beaver activity) creates forest openings allowing regeneration of softwoods and resulting in potential rusty blackbird nesting habitat (Avery 1995). The New Hampshire WAP identifies the use of pesticides on the breeding and wintering grounds, destruction of wintering habitat, acidification of water bodies on the breeding grounds and efforts to control blackbirds on winter roosts may be the contributing to the decline of this bird.

The northern parula is associated with mature moist forests and forested riparian habitats dominated by spruce, hemlock, and fir with an abundance of lichens (especially Usnea) in which they build their nests. There are indications that the northern parula population decline is related to the decline of Usnea, a lichen sensitive to air pollution (DeGraaf and Yamasaki 2001). PIF considers the northern parula a moderate priority for BCR 14, although the region supports 23% of the population (Dettmers, 2005). The northern parula is rarely in deep woods, but also avoids clear cuts and may be sensitive to forest fragmentation (DeGraaf and Yamasaki 2001). It may require at least 250 acres to sustain a breeding population (Robbins et. al. 1989). The 2005 Maine CWCS identifies habitat conservation and research as the two highest priorities in the state for conserving rusty blackbird and northern parula populations (MDIFW 2005).

The floodplain and lakeshore habitats on the Refuge also support a rich diversity of amphibians including mink frog (Rana septentrionalis) and the wooded floodplain hosts several bats including little brown (myotis lucifugus), hoary (Lasiurus cinereus), and northern long-eared (M. septentrionalis). Little brown and northern long-eared bats roost in tree cavities or under loose bark. Long-eared bats roost in large diameter (> 16 inch d.b.h) hardwoods (Sasse and Pekins 1996). The hoary bat roosts in cavities as well as under dense tree foliage (DeGraaf and Yamasaki 2001).

The refuge currently owns, or has approval to acquire an interest in, 1,416 acres if this habitat type. It is primarily on the fee title lands that we plan to conduct active management.

Management Strategies:

- Acquire up to 289 acres of wooded floodplain habitat still in private ownership within the approved refuge boundary, from willing sellers, and manage the fee lands similar to current refuge lands under objective 2.1
- Restore natural vegetation on unauthorized campsites
- Remove surplus cabins that we have acquired as funding allows. Restore site (e.g. loam, seed and/or plant) to native vegetation
- Retain and promote mature riparian softwoods and forest structures favored by northern parulas and rusty blackbirds.
- Protect vernal pool areas from disturbance.
- Retain the majority of trees with cavities, standing dead trees, downed logs, large trees, and large super-canopy trees in the riparian areas for waterfowl, raptors, and other species of conservation concern.
- In woodcock focus areas, utilize accepted management prescriptions to enhance habitat type for this species.
- Manage lowland hardwood and alder to provide adequate food resources for beaver to promote a natural cyclical succession of this habitat type driven by beaver.
- If furbearer management plan is appropriate, implement strategies to manage beaver populations to achieve refuge habitat goals and objective.

- Maintain, enhance and/or create cavity trees within a range of diameter classes in close proximity to water to provide roosting and nesting areas. Maintain suitable habitat between snags (standing dead trees) and feeding areas.
- Restore the hydrology of the Day Flats area by plugging ditches and re-contouring the disturbed areas.
- Mitigate significant recreational impacts as needed

Monitoring Elements:

- Evaluate isolated backwater areas with high potential for waterfowl brood rearing (e.g. quiet backwaters with the combination of forest cover, submerged aquatic vegetation, and intermixed emergent wetlands in Dead Cambridge and Upper Magalloway Rivers) to determine if seasonal boat access closures to reduce disturbance are warranted; implement closures if beneficial
- Identify suitable habitat, and assess habitat quality and habitat use by migratory birds such as northern parula and rusty blackbird. Document habitat use using regional Service protocol for breeding bird surveys, or other appropriate protocols.
- Map and monitor the rare floodplain forest type that occurs along the Magalloway River.
- Monitor habitat impacts from public use
- Inventory active and historic eagle and osprey nesting sites each year
- Conduct bald eagle and osprey surveys in conjunction with the States of Maine and New Hampshire, and conservation partners
- Monitor vernal pool amphibians in areas subject to management activities

Objective 2.2 (Lakeshore Pine-Hemlock)
Maintain up to 520 acres of lakeshore pine-hemlock on Service-owned lands, including those planned for acquisition from willing sellers within the approved refuge boundary, to provide nesting and migrating habitat for birds of conservation concern; to sustain the vegetation diversity within this type, such as the jack pine component; to maintain nesting habitat for bald eagle, osprey, and other raptors; to protect water quality; and, to maintain the scenic and aesthetic values of the Umbagog Lake and other lake shorelines. Important characteristics of this habitat type include:

- large super-canopy pines (eagles, osprey)
- Appropriate disturbance regime that creates openings, reduces shade, and exposes mineral soil, to help promote regeneration of rare jack pine community.
- Water table within 6 ft. of the surface in summer to promote jack pine regeneration

Rationale
The lakeshore pine-hemlock habitat type is comprised of the following NVCS associations: hemlock mesic forest, hemlock-hardwoods forest, hemlock-white pine-red spruce forest, red pine-white pine forest, and jack pine/blueberry/ feathermoss forest see appendix G in the Umbagog NWR CCP, (USFWS, 2009, for a cross-walk between refuge habitat types and other vegetation classification systems).

The refuge currently owns, or has approval to acquire an interest in, 520 acres of this habitat type. Small stands likely occur elsewhere in the approved refuge expansion area, but were too small to be mapped. It is primarily on the fee title lands that we plan to conduct active management.

On the refuge, bald eagle and osprey often nest in large super-canopy trees (large white pines that stick up above the other canopy trees), or in tall snags (standing dead trees) in this habitat type.

Jack pine communities are rare in New Hampshire (S1 rank) and Maine and the stands around Umbagog Lake are the only low-elevation occurrences in New Hampshire (Publicover et al. 1997). These jack

pine stands are primarily scattered along the rocky eastern shore and islands of the lake. Jack pine (Pinus banksiana) is a northern species with highest abundance north of the Great Lakes. The population at Umbagog is at the southern limit of its range. Jack pine is a fire or disturbance-adapted species and can grow on sandy soils, rock outcrops, and sterile burned areas. The total acreage of jack pine on the Maine side of Umbagog Lake is less than 10 acres and most occurs in patches of less than 1 acre (Maine Critical Areas Program 1983).

Through managing this habitat type, other native species will benefit, including nesting merlin and sharp-shinned hawk, olive-sided flycatcher, veery, and yellow-bellied sapsucker, among many other common species.

Management Strategies:

- Acquire up to 288 acres of lakeshore pine-hemlock habitat still in private ownership within the approved refuge boundary, from willing sellers, and manage fee title land similar to current refuge lands under objective 2.2
- Maintain large diameter trees for raptor perch trees and future nest trees
- Ensure recruitment of super-canopy pines.
- Implement cooperative procedures to protect merlin and other forest dependent raptors of conservation concern.
- In jack pine areas, consider limited use of prescribed fire, selective mechanical removal of competing vegetation, thinning, planting, and scarification to expose mineral soils, if appropriate.

Monitoring Elements:

- Where jack pine occurs, map and monitor this type, and consult with state heritage program and other regional ecologists to determine if special management is warranted to sustain this rare ecological community in the Upper Androscoggin watershed.
- Work with NGO's and States to increase monitoring and protection of raptors.

Objective 2.3 (Bald Eagle and Osprey)

Maintain forest stands on the refuge within one mile of high quality bald eagle foraging acres to support 3-4 nesting pairs of bald eagle with a minimum annual 1.0 chick/ pair productivity level over a 5 year average. Given this bald eagle density, and recognizing inter-specific competition, maintain habitat to support 15 nesting pair of osprey on existing and future refuge lands, with a minimum annual 1.0 chick/pair productivity level over a 5 year average. Structures and other factors important to eagles/ osprey include:

- Large super-canopy white pines and snags near water
- Undisturbed nest sites, safe from nest predators and human disturbance, in undeveloped areas.
- Reduced availability of lead fishing tackle (sinkers) and shot in the environment
- Large (> 75 ac), clear, unpolluted, shallow (<6 ft,) bodies of water with abundant prey (fish) populations.

Rationale

The protection of these two species was a primary reason the refuge was established, and they have been a management priority since then. Map 4-2 depicts recent locations of bald eagle and osprey nests on and in the vicinity of the refuge.

Bald eagle

The bald eagle is listed as endangered in New Hampshire and threatened in Maine and continues to be protected by both the Bald and Golden Eagle Protection and the Migratory Bird Treaty Acts. In New Hampshire and Maine, bald eagles are found along major rivers and lakes or near the coast in relatively undisturbed forest patches. Bald eagles perch on, nest in, and hunt from tall, coniferous and deciduous trees or snags (standing dead trees) near water. In the Northeast, white pine is the most common nest tree. Nests are usually within 250 feet of open water near quality foraging areas.

Fish are the preferred food source, although eagles also take waterfowl, aquatic mammals, and scavenge for food. Eagles fish mostly in shallow, low-velocity waters. Chain pickerel, brown bullhead, suckers, white perch, and yellow perch are typical prey in interior Maine (Todd, 2005).

In winter, some individuals may leave the breeding areas and congregate in areas with large expanses of unfrozen, open water. A forest stand that offers thermal protection from inclement winter weather is needed for communal night roosting. Night roosts are most often found near foraging areas, but may be further away if the roost is more protected. Umbagog Lake does not support a winter roost site, although some eagles remain in the area (along the Androscoggin River) and scavenge on the lake.

The main goal of national and state plans for bald eagles is to protect and maintain self-sustaining populations. Supporting breeding pairs with an average annual productivity of at least 1.0 young per occupied nest is highly desired. From 1988-2009 the Leonard Pond nest on Umbagog Lake produced an average of about 1 chick/year. A second nest, near Tidswell Point, has produced about 1.3 chicks/year from 2000-2009. Since 2005, the lake area has consistently supported 3breeding pairs of eagles (4 breeding pairs in 2008). In addition to the locations named previously, nests have also been established at the mouth of the Rapid River, in Sweat Meadows, and at Pine Point. Umbagog Lake is at the headwaters of the Androscoggin River, and the eagles on the lake are part of a regional population with its source in Maine.

Osprey

The Upper Androscoggin River watershed is an important breeding area for osprey. At the core of this area, Umbagog Lake and its associated rivers and backwaters, was the only part of New Hampshire that maintained a breeding population of osprey through the region-wide decline from the 1950s through the 1970s (New Hampshire Fish and Game Department, 2005). Osprey are listed by the State of New Hampshire as a threatened species. Regional threats to osprey include predation, shoreline development, human disturbance, electrocution, mercury, lead shot and sinkers, non-point source pollution (contaminants), and wetland loss (New Hampshire Fish and Game Department, 2005). Osprey populations have experienced strong recoveries on the statewide scale since the early 1980s (Martin et. al. 2006).

Osprey nesting in the U.S. winter in the Caribbean, Central America, and South America (Henry and VanVelzen 1972; Environment Canada 2001). Osprey breeding on the east coast of the U.S. winter primarily in northern South America and sometimes in Cuba and Florida (Martel et. al. 2001). Female osprey generally winter farther south than males and individuals of both sexes show strong fidelity to wintering and breeding sites ((New Hampshire Fish and Game Department, 2005).

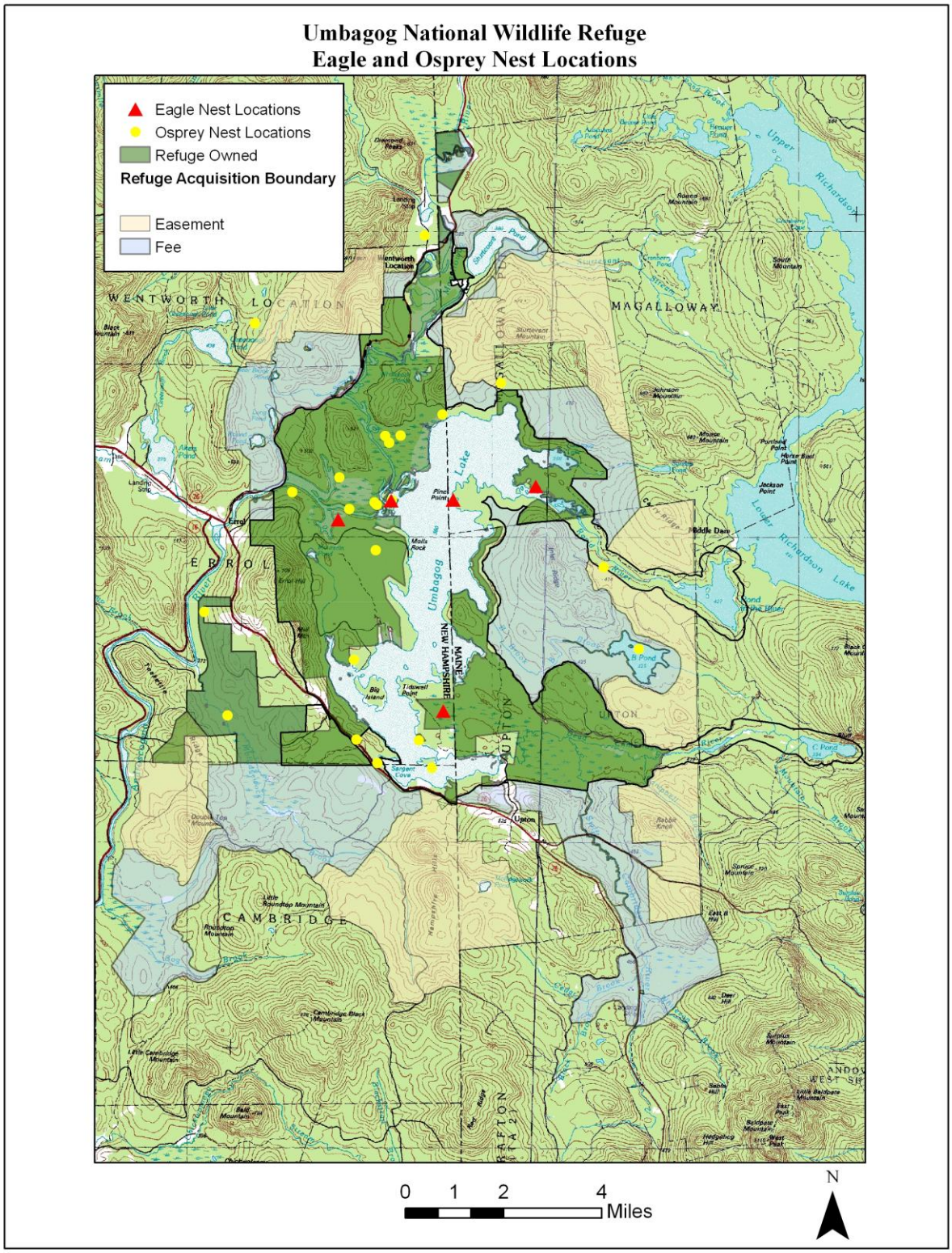
In northern New England, osprey typically establish breeding territories near large lakes, major rivers, and coastal estuaries. A habitat model developed for the Gulf of Maine watershed (USFWS, 2000) found that 90% of 200 osprey nests were located within 0.6 miles of major rivers or lakes greater than 100 acres in size. Osprey generally require areas with dependable fishing sources within 2 to 3 miles, standing trees or other suitable structures located in wetlands, and an ice-free period of no less than 20 weeks ((New Hampshire Fish and Game Department, 2005). Ospreys nest atop a variety of structures including natural

snags (standing dead trees) and artificial poles in or near water with good visibility (DeGraaf and Yamasaki 2001).

Over the past 25 years, the Audubon Society of New Hampshire (ASNH), through a contract with NHFG, has monitored nesting attempts, and also began augmenting nesting sites with artificial nesting structures around the lake in 1977 ((New Hampshire Fish and Game Department, 2005). In 2005, through a contract with the refuge, ASNH and the Biodiversity Research Institute (BRI) conducted aerial surveys for osprey in addition to the ground surveys used from 1996 to 2004. A similar method of aerial surveys had been used by ASNH from the mid-1980's to 1996 when they were discontinued due to a lack of aircraft and qualified pilots. Seven new nests were discovered (5 in New Hampshire, 2 in Maine) and field observations were conducted on 26 osprey nests in the study area. The 2005 survey data estimated 17 territorial pairs of osprey, with 14 of those pairs actively engaged in nesting and 12 of the 14 nesting pairs successfully fledged a total of 18 young (Martin, et. al. 2006). ASNH has found osprey numbers to be variable over time. The 14 nests discovered in 2005 more than doubles the number of active nests found in 2004 (Martin et. al. 2006). In 2008, there were again 14 active nests, 9 of which successfully fledged a total of a total of 14 young. Between 2005-2008 an average of 17 young were fledged/year in the Umbagog area (Martin, 2008).

Todd (2005) suggested a link between an increasing bald eagle population and declining osprey numbers as a result of increased competition and territoriality. He has observed that when bald eagles appear in an area with many ospreys; over time the osprey may decline. Eventually, there are osprey areas and eagle areas with no overlap. Bald eagle population recovery has been reported to displace osprey pairs to less optimal nesting areas that are further from preferred foraging areas (Ewins, 1997).

Map 4-2. Eagle and Osprey Nest Locations.



Management Strategies:

- Protect active bald eagle and osprey nests from predators and human disturbance using outreach and visitor contact, buoy lines, restricted access, predator guards and other tools as warranted
- Implement area closures around bald eagle nest trees; place visible floating buoys and signs to alert all boaters to closure area
- Work cooperatively with State agencies and private conservation organizations on bald eagle and osprey management
- Support efforts to eliminate practices that contribute lead and other contaminants to the environment
- Identify and protect super-canopy trees within 1 mile of high quality foraging habitat to support nesting and perching by bald eagles and osprey.
- Protect individual nest trees with at least a 600-foot buffer area.
- Protect historic nest sites, nest trees, and partially constructed nest trees.
- Manipulate pines in high quality habitat areas to promote new nesting sites.
- Develop and implement outreach methods designed to minimize discarded fishing tackle

Monitoring Elements:

- Work with NGO's and States to increase monitoring and protection of raptors
- Inventory active and historic eagle and osprey nesting sites each year

Goal 3. Manage upland forest habitats, consistent with site capability, to benefit Federal trust species and other species of conservation concern.

Background

Forests are the dominant land cover in northern New England. Ninety percent of the Upper Androscoggin watershed that encompasses Umbagog Lake is forested. The dominant tree species are red spruce (*Picea rubens*), balsam fir (*Abies balsamea*), sugar maple (*Acer saccharum*), yellow (*Betula alleghaniensis*), and white birch (*B. papyrifera*), and red maple (*Acer rubrum*) forming a mixed hardwood-softwood landscape. Embedded within this matrix of hardwoods and softwoods are three broad habitat types found in varying amounts: spruce-fir, northern hardwoods, and mixed hardwood-softwood. The spruce-fir type is dominated by at least 75% red spruce and/or balsam fir, occurring at higher elevations (above 2700'), on thin, rocky soils at mid-elevations, and in valley bottoms on nutrient-poor soils. A mixture of at least 75% sugar maple, yellow birch, and beech (*Fagus grandifolia*), dominates the northern hardwoods type that occurs on fine-textured soils at lower and mid-slopes. Mixed hardwood-softwood habitat is a broad type that includes varying amounts of the major tree species in the region, depending on site conditions (Publicover and Weihrauch 2003). Leak (2004) considers a stand with 25-65% softwood a "mixed wood" stand. White pine (*Pinus strobus*), hemlock (*Tsuga canadensis*), white spruce (*Picea glauca*), northern white cedar (*Thuja occidentalis*), tamarack (*Larix larcina*), black spruce (*Picea mariana*), yellow and white birch, and red maple are also present in varying amounts in these forests.

The Umbagog Lake landscape of today supports more hardwoods than likely occurred historically. This reflects a forest composition that was affected by multiple cycles of timber harvesting over the past 150 years. Selective harvesting of softwoods has converted many spruce-fir stands to mixed stands, and mixed stands to hardwood stands. In the absence of further human disturbance these forests through natural succession and disturbance patterns would have shifted to a higher proportion of softwood (Publicover and Weihrauch 2003). Historically, the mixed hardwood-softwood forest was the dominant forest type within the Upper Androscoggin Watershed and surrounding Umbagog Lake (Kuchler 1964; Cogbill, 2004). This is consistent with the site capabilities of the Refuge expressed through the ecological land units (a combination of elevation, bedrock geology, and topography).

Presettlement forests are believed to have been multi-aged with a diverse structure including a variety of tree sizes, many large-diameter trees, multiple canopy layers, deep forest duff, and "pit-and-mound" forest floor. The canopy, shrub, and herbaceous layers of the mixed forests around Umbagog today have varying composition and coverage depending on specific site conditions and disturbance history (Rapp 2003). In addition to bird species of concern, a structurally complex (e.g., vertical diversity, coarse woody debris, large diameter trees with cavities) mixed forest landscape also supports large wide-ranging mammals including marten, fisher, bobcat, and lynx (Ray 2000).

No areas of old growth forest occur on the Refuge, although there are a few conifer stands with some late-seral characteristics (such as large diameter trees). Hagen and Whitman (2004) report on the looming loss of late-successional forest in working forest landscapes including northern New England and the consequences for forest biodiversity. They note that forests develop along a continuum and even stands with a harvest history can retain and develop old growth characteristics such as large live trees 100-200 years old, large dead trees, and fallen logs. Species associated with these characteristics include mosses, lichens, fungi, and insects.

Natural disturbance regimes are affected by long-term climate change and disturbance patterns on the landscape are highly influenced by soil, topography, and forest type (Lorimer 2001, Lorimer and White 2003). Natural disturbance patterns for this region occur at two different scales. Large-scale, stand replacement, disturbances from fire and wind historically occurred infrequently, on the magnitude of 1000+ years. Small-scale disturbances, creating singletree fall gaps, occurred frequently (50-200 year return rates) (Lorimer 1977, Seymour et al. 2002). Pure stands of spruce and fir are much more susceptible to windthrow, insect outbreaks, and crown fires, than associated hardwood species, because of their shallow root system, prevalence in swamps, on upland sites with thin, stony soils and on upper slopes exposed to high winds. Large areas of mixed spruce-hardwood that typically occur on better soils are rarely destroyed (i.e., stand replacement) by large-scale disturbances (Lorimer and White 2003). Historical disturbance patterns are likely to change under the influence of climate change, along with changing weather patterns. The New England region will likely see more variable precipitation, intense storms, drought, ice storms, and increased wind and fire disturbance.

The range center of most of the region's tree species is predicted to shift northward by as much as 350-500 miles over the coming century. Current climate change models indicate that a reduction in spruce-fir, maple/beech/birch, and hemlock habitat in New Hampshire is likely by century's end. Sugar maple and other northern hardwoods will be displaced northwards. Productivity and reproduction of boreal species, particularly spruce-fir, will likely decrease, while vulnerability to diseases and pests may increase. Balsam fir and red spruce habitat across New England and New York is predicted to decrease by 70-85% by 2100 (Frumhoff, et al. 2007). Trees better adapted to warmer climates, such as oak, hickory and pines, may increase their ranges (Iverson et al. 2007).

Forest management strategies to mitigate the effects of climate change include: reducing or eliminating other environmental stressors to the extent possible; managing lands to reduce risk of catastrophic events; managing for self-sustaining populations; and looking for opportunities, through land protection and conservation, to ensure widespread habitat availability and connectivity. Increased biological monitoring and inventories will enable the refuge to effectively respond to the uncertainty of future climate change effects, using an adaptive management framework.

We anticipate that our management will help make our forests generally more resilient to multiple stressors, including climate change. We plan to monitor our forest systems and the impacts of our forest management strategies, and modify our management practices appropriately, as necessary. We recognize that climate change may influence the trajectory of our forest systems in unpredictable ways and anticipate that we may have to adjust our objectives and management strategies accordingly. The use of

accepted silvicultural practices will perpetuate our habitat types. Where feasible, our management strategies will favor or increase the conifer component of stands on appropriate sites and will encourage species and age diversity.

Objective 3.1 (Mixed Spruce-Fir/Northern Hardwood Forest)
Conserve up to 59,611 acres of mixed spruce-fir/northern hardwood forest on Service-owned lands, including those planned for acquisition from willing sellers within the approved refuge boundary, to sustain well-distributed, high quality breeding and foraging habitat for species of conservation concern, including blackburnian, black-throated green, and Canada warblers, and American woodcock. Also, where consistent with management for those refuge focal species, protect critical deer wintering areas and provide connectivity of habitat types for wide-ranging mammals

- provide habitat for up to 3,975 pairs of blackburnian warblers (based on an estimated density of 4.94 acres/pair)
- provide habitat for up to 2,890 pairs of black-throated green warbler (based on an estimated density of 6.79 acres/pair
- provide habitat for up to 1,040 pairs of Canada warblers (based on an estimated density of 13.84 acres/pair
- provide habitat for up to 280 singing male woodcock (based on an estimated density of 23.8 acres/ singing male (Weik, 2006; Dettmers, 2006).

We recognize that these estimates are based on habitat acres alone, and may not fully take into account intra-specific competition among other breeding bird species in the same area.

Rationale
In the Partners in Flight (PIF) Eastern Spruce-Hardwood Physiographic Area 28 Plan, the mixed forest is identified as a high priority habitat that is critical for "long-term planning to conserve regionally important bird populations" (Rosenberg and Hodgman 2000). The breeding bird survey data at Umbagog NWR shows the importance of mixed forest, with patches of lowland spruce fir and northern hardwoods, for species of concern such as blackburnian warbler (Dendrioca fusca), Canada warbler Wilsonia canadensis), and black-throated green warbler (Dendroica virens) (Jennifer Casey, USFWS, unpublished data). We have selected these, and the American woodcock, as our refuge focal species for management (see Umbagog CCP (USFWS, 2009) for details on the objectives and strategies summarized below and Map 2-2 for the location of this forest type and its component habitat types on existing refuge lands).

Focal Species Habitat Requirements
The *blackburnian warbler* is associated with mature conifer habitats (> 80% canopy cover) of spruce, fir, hemlock, and pines, and in spruce-fir/hardwood mixed habitats including deciduous stands with patches of conifers. It nests and gleans insects in the upper canopy of conifers, especially spruce and hemlock, if present, and rarely pines (DeGraaf and Yamasaki 2001). Males sing from the tops of the tallest conifers, preferably over 60 feet. The blackburnian warbler is a moderate priority with a high regional responsibility within Bird Conservation Region (BCR) 14 (Dettmers, 2005). Approximately 25% of the global population occurs in this region. This warbler is of conservation concern because of its relatively small total range, its preference for mature conifers, and its restricted winter range in the subtropical forests of northern South America. Declines are recorded for New England although the overall population appears to be stable. It is considered a forest interior species, susceptible to forest fragmentation and short rotation timber harvesting (50 years or less) (Hagen et al. 1996; Morse, 2004).

The *Canada warbler* is declining across much of its range and is listed as highest priority in BCR 14 (Dettmers, 2005). This bird is found throughout the watershed, and is not tied specifically to any of the three refuge upland habitat types, but may be tied more directly to a well-developed understory or shrub layer. PIF also has a goal of increasing the Canada warbler continental population by 50% (Rich et al. 2004). The Maine CWCS identifies habitat conservation and research as the two highest priorities in the state for conserving Canada warblers (MDIFW, 2005).

The *black-throated green warbler* is one of the forest-interior species most closely associated with a mixed forest. Black-throated green warblers are a moderate priority in BCR 14, with a high regional responsibility (18.4% of the global population), and a moderate regional threat level. This species is generally abundant and stable in the region. Although it occupies a wide range of forested habitat types, in the Northeast, it occurs at highest densities in closed canopy mid-to-mature forest with a significant conifer component. This foliage-gleaning warbler generally forages high in the canopy, but at a lower height than blackburnian warblers (Morse, 1967). Spruce (particularly red spruce) and paper birch are favored foraging substrates. Although it will nest in deciduous trees, preferred nest sites are in dense conifer foliage on a limb or tree fork, at a height of about 20 ft. (DeGraaf and Yamasaki, 2001; Foss, 1994). Large spruce trees are favored male singing perches (Morse, 1993). Black-throated green warblers appear to require fairly large forest patches and a generally forested landscape (Norton, 1999). Askins and Philbrick (1987) found that they disappeared from a 250 acre forest tract that became isolated from other forested habitat. Black-throated green warbler densities also decline in heavily thinned forest (Morse, 1993). However, structurally heterogeneous forests that include small gaps provide improved foraging opportunities for this warbler (Smith and Dallman ,1996).

The *American woodcock* is a highest priority species in BCR 14 (Dettmers, 2005). Woodcock require several different habitat conditions that should be in close proximity to one another, and can consist of both uplands and wetlands habitat types. These include clearings for courtship (singing grounds), large openings for night roosting, young, second-growth hardwoods (15-30 years) for nesting and brood-rearing, and foraging areas (Sepik et al. 1981; Keppie and Whiting 1994). These habitat conditions occur naturally on the refuge and can be expanded through habitat manipulation. Lorimer and White (2003) estimate that natural disturbances in the pre-settlement forests created about 1-3% early successional habitat in mixed woods and northern hardwood forests and up to 7% in spruce flats that are more susceptible to blowdown.

Other Species Benefiting From Our Focal Species Management

Other birds of high conservation concern in BCR 14 that breed or forage in the mixed forest which we expect will benefit over the long-term from our management include: bay-breasted warbler (BCR highest priority), and boreal chickadee, Cape May and black-throated blue warblers (BCR high priority). Cape May and bay-breasted, in particular, prefer stands dominated by conifer, or pure conifer, which our management will emphasize. While these species do not presently occur at high densities in our area, we predict that our management efforts will help mitigate the impacts of climate change, and may increase their persistence on the landscape, as our forest management tends toward favoring spruce, and as we allow for some stands to tend toward older age classes.

Our management for focal species on both current and future refuge lands will serve to ensure long-term conservation of critical deer wintering areas and provide habitat connectivity for wide-ranging mammals including American marten, fisher, bobcat, black bear (Ray 2000), and potentially for the Federal-listed lynx.

General Management Strategies (see Umbagog CCP, appendix E (USFWS, 2009), for additional details)**:**

- Perpetuate, through accepted silvicultural practices, the three habitat types that make up our upland forests, through time, distributed within the refuge based on site capability and our ability to access and manage them. Ensure that habitat patch size and connectivity are sufficient for species requiring large blocks of unfragmented habitat
- Initiate acquisition from willing sellers on up to 48,766 acres of upland forest still in private ownership within the approved refuge boundary, and manage fee lands as described in objective 3.1.

General Monitoring Elements:

- Conduct upland forest breeding bird surveys according to regional Service protocols to track breeding bird trends on the refuge.
- Conduct a detailed inventory in each of the three habitat types to identify or refine specific silvicultural prescriptions.
- Conduct resource surveys prior to forest management to ensure that resources of concern are identified and impacts minimized or eliminated (including vernal pool monitoring).

Sub-Objective 3.1a (Spruce-Fir Habitat Type)
Manage up to 28,863 acres of spruce-fir on Service-owned lands, including those planned for acquisition from willing sellers within the approved refuge boundary, to:

Sustain singing, nesting and feeding habitat for blackburnian and black-throated green warblers (refuge focal species) by perpetuating a high (>70%) crown closure, favoring spruce during stand improvement, and maintaining super- canopy trees

Maintain at least 50% of deer wintering areas (see Map 4-3) as quality shelter at any given time, consistent with management of our focal species

Provide connectivity of forested habitat types for wide-ranging mammals, consistent with management for our focal species.

Provide other structural characteristics to improve stand diversity for other native wildlife species dependent on this habitat type. This will include retention of approximately six live cavity trees or snags (standing dead trees/ acre), with at least 1 of these exceeding 18 inches/dbh, and three others exceeding 12 inches dbh, and retaining coarse woody debris and super dominant or super- canopy trees.

Acquire up to 26,517 acres of this cover type from willing sellers within the approved refuge boundary, and manage fee title lands similar to current refuge lands under objective 3.1a.

Work with state partners to identify and protect critical deer wintering areas (see Map 4-3 for location of existing known deer wintering areas)

Additional attributes of this habitat type important to focal species, such as blackburnian warbler, black throated-green warbler, deer, and associated communities include:

- Mature interior forest (>60 yrs)
- Tall (>50 ft) conifers (especially spruce and/or hemlock)
- Large horizontal upper branches for nesting sites
- Medium-high tree densities

- Large (>100 ha) patches of unfragmented forested habitat
- Multi-layered stand structure with tree-fall gaps

Rationale
The spruce-fir habitat type includes both high and low elevation spruce-fir. It is comprised of the following NVCS associations: lowland spruce-fir community, red spruce rocky summit, and a black spruce-red spruce community (see Umbagog CCP, Appendix G (USFWS, 2009) for a crosswalk between refuge habitat types and other vegetation classification systems). It is an important ecological component of the diversity of the Upper Androscoggin River Watershed and supports many species of conservation concern.

The 1995 New Hampshire Forest Resources Plan describes the spruce-fir habitat type as supporting more rare animal species than other major habitat types and considers mature spruce-fir a rare habitat type (New Hampshire Division of Forests and Lands, 1995).

While we believe this habitat type was much more dominant historically in the mixed forest matrix than we see on the landscape today, its extent and age class distribution in New Hampshire and Maine has been affected by natural disturbances such as spruce budworm and bark beetle outbreaks, and from human disturbances, primarily logging. The 2005 New Hampshire Wildlife Action Plan (WAP) identifies development, timber harvest, non-point pollution, and altered natural disturbance regimes as the most challenging issues currently facing the conservation of this habitat type (New Hampshire Fish and Game Department, 2005).

Given the apparent decline in spruce-fir habitat, its significance to our mixed forest focal species (blackburnian and black-throated green warblers), and its importance in State conservation plans, the spruce-fir habitat type will be our highest priority for upland forest management. Since our management will tend to create larger blocks of mature spruce-fir on the landscape, we anticipate that a by-product of our management will be the improvement of habitat quality for species more closely tied to this habitat, such as bay-breasted warbler, boreal chickadee, and gray jay, among others.

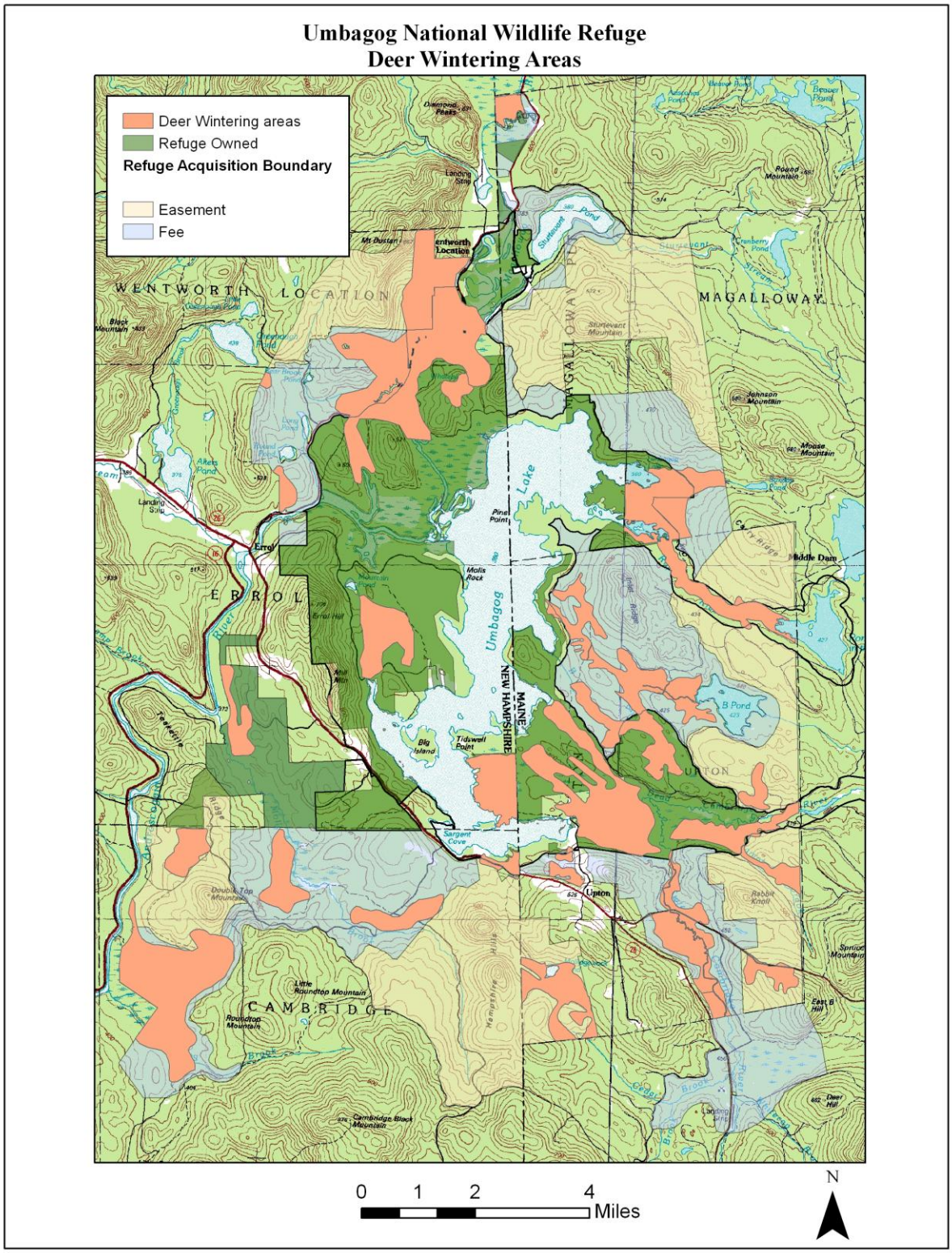
Management Strategies:
- Improve habitat structural diversity for refuge focal species through light pre-commercial and commercial thinning and/or other stand improvement operations, as appropriate. We will favor spruce during all stand improvements.
- Regenerate this habitat type through accepted silvicultural practices. Methods include, but are not limited to: 1) Utilize primarily single tree or group selection uneven-aged management techniques, and to a lesser extent, clearcutting, or shelterwood even-aged techniques, 2) treatments should be timed to optimize the ability of the site to regenerate spruce and other conifer, 3) target age class goals under management will range from 100-130 years; and, 4) the size of each treatment action and cutting interval will be determined by management unit size, silvicultural prescription, and rotation age.
- In critical deer wintering areas maintain updated maps of critical areas and manage these stands, to the extent compatible with management of Federal trust resources, to ensure long-term continuation of this habitat. The overall target would be to maintain a minimum of 50% of a deer wintering area as quality shelter at any point in time. Quality shelter includes softwood cover over 35 feet tall and 70% or higher crown closure (Reay et al. 1990).
- Retain wildlife forage and mast producing trees (such as beech, aspen, striped maple, black cherry)
- Retain coarse woody debris

- Protect vernal pools, headwater streams, and seeps with appropriate buffers and management

Monitoring Elements:

- Refuge staff will assist state agencies with ground surveys of wintering deer areas on refuge lands.
- Continue monitoring landbirds in this habitat type

Map 4-3. Deer Wintering Areas.



Sub-Objective 3.1b (Conifer-Hardwood "Mixed Woods" Habitat Type)
Manage up to 17,265 acres of conifer-hardwood mixed woods with a high conifer component on Service-owned lands, including those planned for acquisition from willing sellers within the approved refuge boundary to:

Sustain singing, nesting and feeding habitat for blackburnian and black-throated green warblers (refuge focal species) by perpetuating a high (>70%) crown closure, favoring spruce during stand improvement, and maintaining super canopy trees. Enhance foraging habitat for the black-throated green warbler and other native species dependent on this habitat type by developing small gaps to promote a diverse, layered understory. We will favor conifers wherever possible based on site capability.

Provide connectivity of forested habitat types for wide-ranging mammals, consistent with management for our refuge focal species.

Provide other structural characteristics to improve stand diversity for other native wildlife species dependent on this habitat type. This will include retention of approximately 6 live cavity trees or snags (standing dead trees)/ acre, with at least 1 of these exceeding 18 inches/dbh, and 3 others exceeding 12 inches dbh, and retaining coarse woody debris and super dominant trees.

Acquire up to 13,406 acres of this cover type from willing sellers within the approved refuge boundary, and manage fee title lands similar to current refuge lands under objective 3.1b.

Additional attributes of this habitat type important to focal species, such as blackburnian warbler, black throated-green warbler, and associated communities include:

- Mature interior forest (>60 yrs) with a high conifer component
- Tall (>50 ft) conifers (especially spruce and/or hemlock)
- Large horizontal upper branches for nesting sites
- Medium-high tree densities
- Large (>100 ha) patches of unfragmented forested habitat
- Multi-layered stand structure with tree-fall gaps

Rationale
The conifer-hardwood mixed woods habitat type is comprised of the following NVCS associations: aspen-fir woodland, successional spruce-fir forest, and red spruce-hardwood forest (refer to Umbagog CCP, Appendix G, (USFWS, 2009), for a crosswalk between Umbagog habitat types and other vegetation classification systems). We believe the conifer component within this habitat type was much greater over the last 150 years than it is today, due to the past 20 years of logging practices. The New Hampshire WAP identifies development and acid-deposition as the most challenging issues facing this habitat type (New Hampshire Fish and Game Department, 2005). The 2005 Maine CWCS identifies large-scale forestry operations that result in habitat fragmentation, change in over- and under-story species composition (stand conversion), reduction in rotation length, and loss through development as major threats to this habitat type (MDIFW, 2005).

Management Strategies
- Improve habitat structure for refuge focal species through light pre-commercial and commercial thinning and/or other stand improvement operations. We will favor spruce during all stand improvements.

- Retain wildlife forage and mast producing trees (such as beech, aspen, striped maple, black cherry)
- Retain coarse woody debris
- Protect vernal pools, headwater streams, and seeps with appropriate buffers and management
- Regenerate this habitat type through accepted silvicultural practices. Favor conifer on appropriate sites. Methods include, but are not limited to:

  On conifer- dominated sites
- utilize primarily single tree or group selection uneven-aged management techniques, and to a lesser extent, clearcutting, or shelterwood even-aged techniques;
- treatments should be timed to optimize the ability of the site to regenerate spruce and other conifer;
- target age class goals under management will range from 100-130 years;
- the size of each treatment action and cutting interval will be determined by management unit size, silvicultural prescription, and rotation age;
- in areas of advanced, healthy conifer regeneration, we will implement silvicultural techniques to protect it.

  On hardwood- dominated sites
- utilize small group selection with up to 1/5 to 1/2 acre group sizes;
- target age class goals under management are 100-200 years; and,
- cutting cycles will be 15 to 20 years in order to maintain understory development.

Monitoring Elements:

See general monitoring elements, above.

Sub-Objective 3.1c (Northern Hardwood Habitat Type)

Manage up to 13,483 acres of northern hardwood habitat type on Service-owned lands, including those planned for acquisition from willing sellers within the approved refuge boundary, and on sites optimally suited for hardwood growth to:

Provide foraging habitat for blackburnian and black-throated green warblers (refuge focal species) by developing multi-aged stands and a mid- to high canopy closure

Sustain breeding, nesting and foraging habitat for Canada warblers, a refuge focal species, by developing openings, a diverse, layered understory, and promoting the aspen and birch community. This management would also benefit American woodcock (see discussion below)

Provide other structural characteristics to improve stand diversity for other native wildlife species dependent on this habitat type. This will include retention of approximately six live cavity trees or snags (standing dead trees)/ acre, with at least one of these exceeding 18 inches/dbh, and three others exceeding 12 inches dbh, and retaining coarse woody debris, and super dominant trees. Where possible, we will maintain and encourage the development of mast producing trees (e.g. black cherry, mountain ash, beech).

Acquire up to 8,843 acres of this cover type from willing sellers within the approved refuge boundary, and manage fee title lands similar to current refuge lands under objective 3.1c.

Additional attributes important to focal species such as Canada warbler and associated communities include:

- Uneven-aged, multi-story structure with good species diversity and relatively low (<17 m) canopies
- Canopy gaps
- Structurally complex, well-developed understory of herbaceous plants (especially ferns and mosses) and shrubs/ saplings, 2-6 m. tall, <8 cm dbh (total ground cover > 70%)
- Presence of exposed, emergent perch trees (relatively isolated trees that emerge > 3m above surrounding canopy)
- Limited herbivore/ ungulate browse
- Abundant coarse woody debris, including large decaying logs and stumps and rootwads
- Uncompacted, uneven forest floor with hummocks

Rationale

The northern hardwood habitat type is comprised of the following NVCS associations: red maple-yellow birch early successional woodland, northern hardwood forest, semi-rich northern hardwood forest, and paper birch talus woodland (refer to Umbagog CCP, Appendix G (USFW, 2009), for a crosswalk between Umbagog habitat types and other vegetation classification systems). This habitat type is more extensive on the landscape today than probably occurred over the last 150 years (Cogbill, 2004). Similar to the spruce-fir type, its distribution is largely due to site capability and land-use changes over time. It is also an important ecological component of the diversity of the Upper Androscoggin River watershed.

The northern hardwood habitat type is a deciduous forest dominated by sugar maple, yellow birch and American beech on well-drained soils on mid-elevation slopes. American beech becomes more common in older stands. Most of the area covered by this community was logged at some time in the past (Rapp 2003). Aspen-birch is another forest component of this habitat type, although it can also be a temporary, early successional feature of any of the three broad upland habitat types on the refuge. White birch, quaking and bigtooth aspen, and pin cherry can dominate an area following a large disturbance such as fire or clearcut; however, these shade intolerant species are eventually replaced with more shade tolerant species characteristic of the particular site conditions.

Management Strategies:

- Improve habitat structure for refuge focal species through light pre-commercial and commercial thinning and/or other stand improvement operations no earlier than mid-successional stage (> 6 m high).
- Leave woody debris on site
- Regenerate these habitat types through accepted silvicultural practices. Methods include, but are not limited to:
- Utilize single tree or small group selection of up to 1/2 acre group sizes,
- target age class under management are 100-200 years; and,
- cutting cycles of 15 to 20 years in order to maintain understory development.
- Retain wildlife forage and mast producing trees (such as beech, aspen, striped maple, black cherry)
- Protect vernal pools, headwater streams, and seeps with appropriate buffers and management

Monitoring Elements:

See general monitoring elements, above.

Sub-Objective 3.1d (Woodcock Focus Areas)
Manage 2,664 acres in woodcock focus areas to provide and sustain all life stage habitat requirements for woodcock . Refer to Map 4-4 for location of woodcock focus areas.

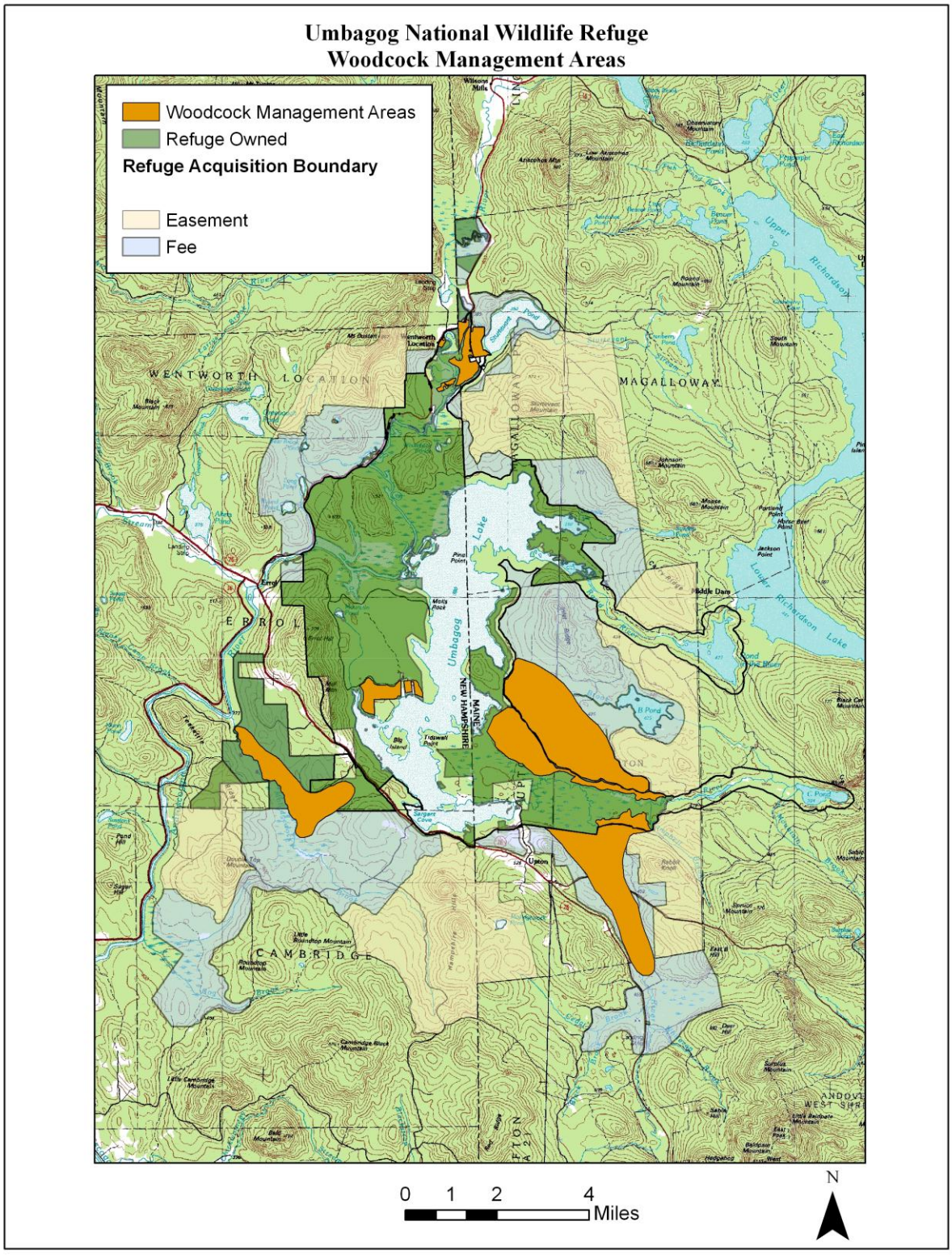
Management Strategies:

- Use accepted silvicultural practices in woodcock focus areas to create openings, promote understory development, and sustain early successional habitat for American woodcock and Canada warbler.
- Generally, use group selection, clearcuts or patch cuts of up to 5 acres in size. Some larger roosting fields may also be maintained.
- Cutting cycles will be approximately 8-10 years on a 40 year rotation. Some 3-5 acre openings may be permanently maintained primarily by mowing and brush clearing using mechanized equipment.
- Perpetuate aspen-birch communities where they exist, and strive to achieve an appropriate distribution of regenerating, young, mid and mature age classes

Monitoring Elements:

- Conduct woodcock singing male surveys to document wildlife response to habitat management.

Map 4-4. Woodcock Focus Areas.



Chapter 5. Habitat Management Units and Prescriptions

Management Units

Management unit boundaries were determined based on habitat type, similarity of management approach and management logistics (see Map 5-1 and Table 5.1). The goal was to create units that could be managed ecologically, be recognized by Refuge staff, and that made sense from a logistical standpoint. Within each Management Unit, one or more Treatment Areas may be delineated. The prescriptions and strategies are targeted at meeting the suite of habitat objectives identified for each Management Unit. Umbagog NWR developed a set of habitat-based objectives through its CCP process.

Table 5.1. Habitat Management Units at Umbagog NWR

Habitat Management Unit	Current Habitat Types	Habitat Objectives
Open Water and Riparian	• Open water and submerged aquatic vegetation • Wooded floodplain • Lakeshore pine-hemlock	1.5, 1.6, 2.1, 2.2, 2.3
Non-forested Wetlands	• Fen and flooded meadow • Boreal fen and bog • Scrub-shrub wetlands	1.1,1.2,1.4
Forested Wetlands	• Northern white-cedar • Boreal fen and bog	1.2,1.3
Upland Forest	• Spruce-fir • Mixed woods • Northern hardwoods • Recently harvested	3.1a,b,c,d
Woodcock Focus Area	• Wooded floodplain • Scrub-shrub wetlands • Northern hardwoods	3.1d

I. Open Water and Riparian Management Unit

Objective 1.5 (Open Water and Submerged Aquatic Vegetation)

…… manage up to 5,903 acres of open water ….. to maintain floating-leaved and submerged aquatic vegetation (SAV) and native fish such as brook trout. Also, manage waters to provide loafing and foraging areas for water birds, and to maintain high water quality to benefit other native vertebrate and invertebrate aquatic life.

Objective 1.6 (Common Loon)

……conserve and manage common loon territories to support a 5-year annual average of 14 nesting pairs on Umbagog Lake and its tributaries, and 4 additional pairs within the expansion area, and achieve a 5-year average annual productivity of 0.5 chicks per nesting pair.

Objective 2.1 (Wooded Floodplain)

Manage up to 1,429 acres of wooded floodplain….to provide habitat for nesting cavity-dependent waterfowl and other priority bird species of regional conservation concern, including northern parula and rusty blackbird. In addition, manage perching areas for bald eagle, and brood foraging areas for American black duck and other waterfowl. Also, where this habitat type overlays woodcock focus areas, manage for feeding and nesting American woodcock**.**

Objective 2.2 (Lakeshore Pine-Hemlock)

Maintain up to 520 acres of lakeshore pine-hemlock….. to provide nesting and migrating habitat for birds of conservation concern; to sustain the vegetation diversity within this type, such as the jack pine component; to maintain nesting habitat for bald eagle, osprey, and other raptors; to protect water quality; and to maintain the scenic and aesthetic values of the Umbagog Lake and other lake shorelines**.**

Objective 2.3 (Bald Eagle and Osprey)

Maintain forest stands on the refuge within one mile of high quality bald eagle foraging acres to support 3-4 nesting pairs of bald eagle with a minimum annual 1.0 chick/ pair productivity level over a 5 year average. Given this bald eagle density, and recognizing inter-specific competition, maintain habitat to support 15 nesting pair of osprey on existing and future refuge lands, with a minimum annual 1.0 chick/pair productivity level over a 5 year average.

II. Non-forested Wetlands Management Unit

Objective 1.1 (Fen and Flooded Meadow)

Manage up to 689 acres of fen and flooded meadow……Provide nesting and brood rearing habitat for American black and ring-necked ducks, pied-billed grebe and other marsh birds, and brood rearing habitat for wood duck and common goldeneye. Also, manage undisturbed staging areas for migrating waterfowl and stopover areas for migrating shorebirds from late August through mid-October

Objective 1.2 (Boreal Fen and Bog, in part [non-forested component])

Manage up to 4,086 acres of boreal fen and bog …..to sustain the health and integrity, and uniqueness of the rare species and natural communities, such as the Floating Island National Natural Landmark, the circumneutral pattern fen, and other peatlands.

Objective 1.4 (Scrub-Shrub Wetland)

Manage up to 1,807 acres of scrub-shrub wetland….as foraging and brood habitat for American woodcock, and to provide nesting and migratory habitat for birds of conservation concern, such as Canada warbler.

III. Forested Wetlands Management Unit

Objective 1.2 (Boreal Fen and Bog; in part [forested component])

The boreal fen and bog habitat type includes both forested and non-forested peatlands. See objective 1.2, above.

Objective 1.3 (Northern White Cedar)

Manage up to 1,031 acres of northern white cedar …..to sustain the health and diversity of natural and rare ecological communities in the Upper Androscoggin watershed.

IV. Upland Forest Management Unit

The upland forest management unit has been further sub-divided into forest management sub-units. The location of these sub-units is shown in Map 5-2.

Objective 3.1 (Mixed Spruce-Fir/Northern Hardwood Forest)

Conserve up to 59,611 acres of mixed spruce-fir/northern hardwood forest…. to sustain well-distributed, high quality breeding and foraging habitat for species of conservation concern, including blackburnian, black-throated green, and Canada warblers, and American woodcock. Also, where consistent with management for those refuge focal species, protect critical deer wintering areas and provide connectivity of habitat types for wide-ranging mammals.

Sub-Objective 3.1a (Spruce-Fir Habitat Type)

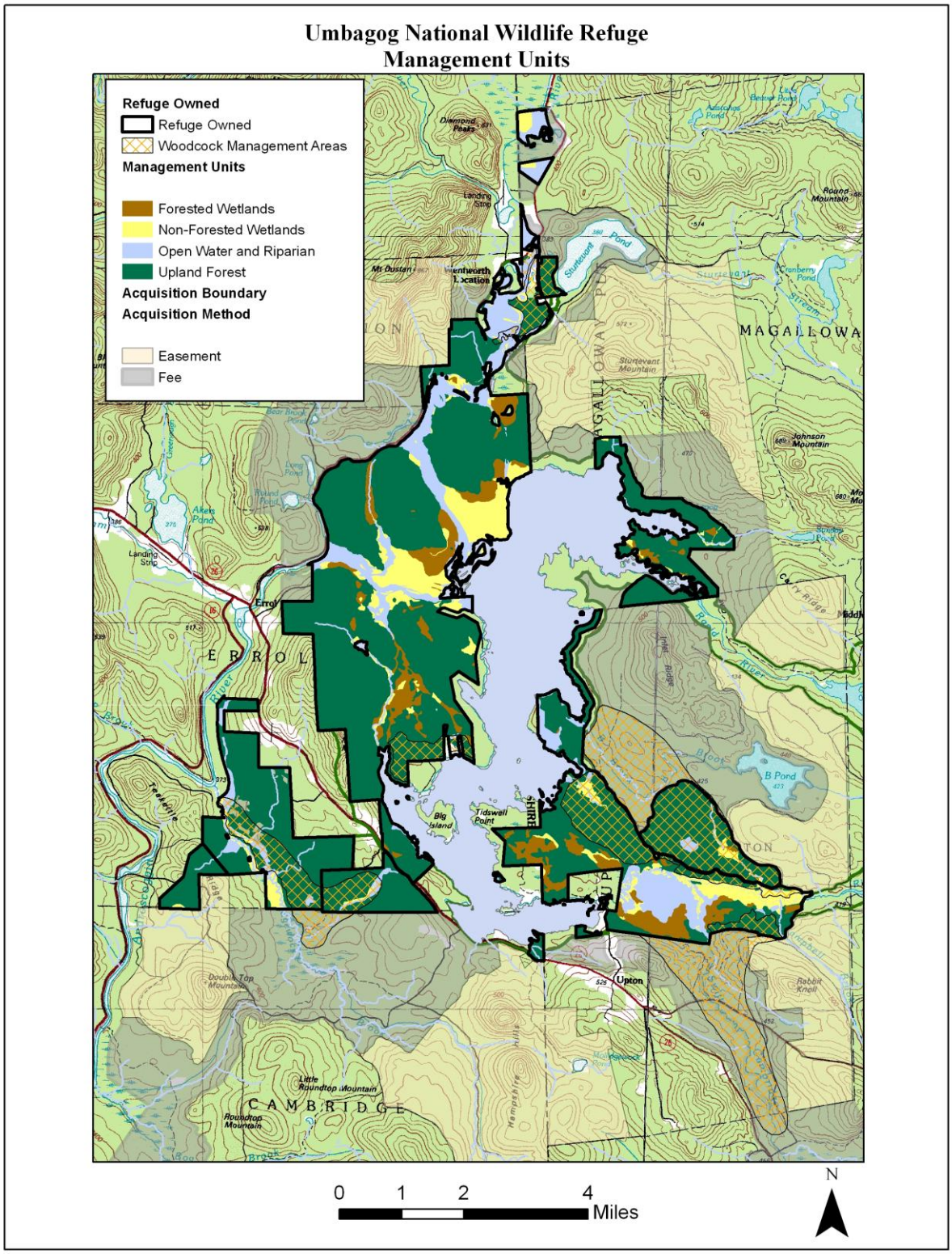
Sub-Objective 3.1b (Conifer-Hardwood "Mixed Woods" Habitat Type)

Sub-Objective 3.1c (Northern Hardwood Habitat Type)

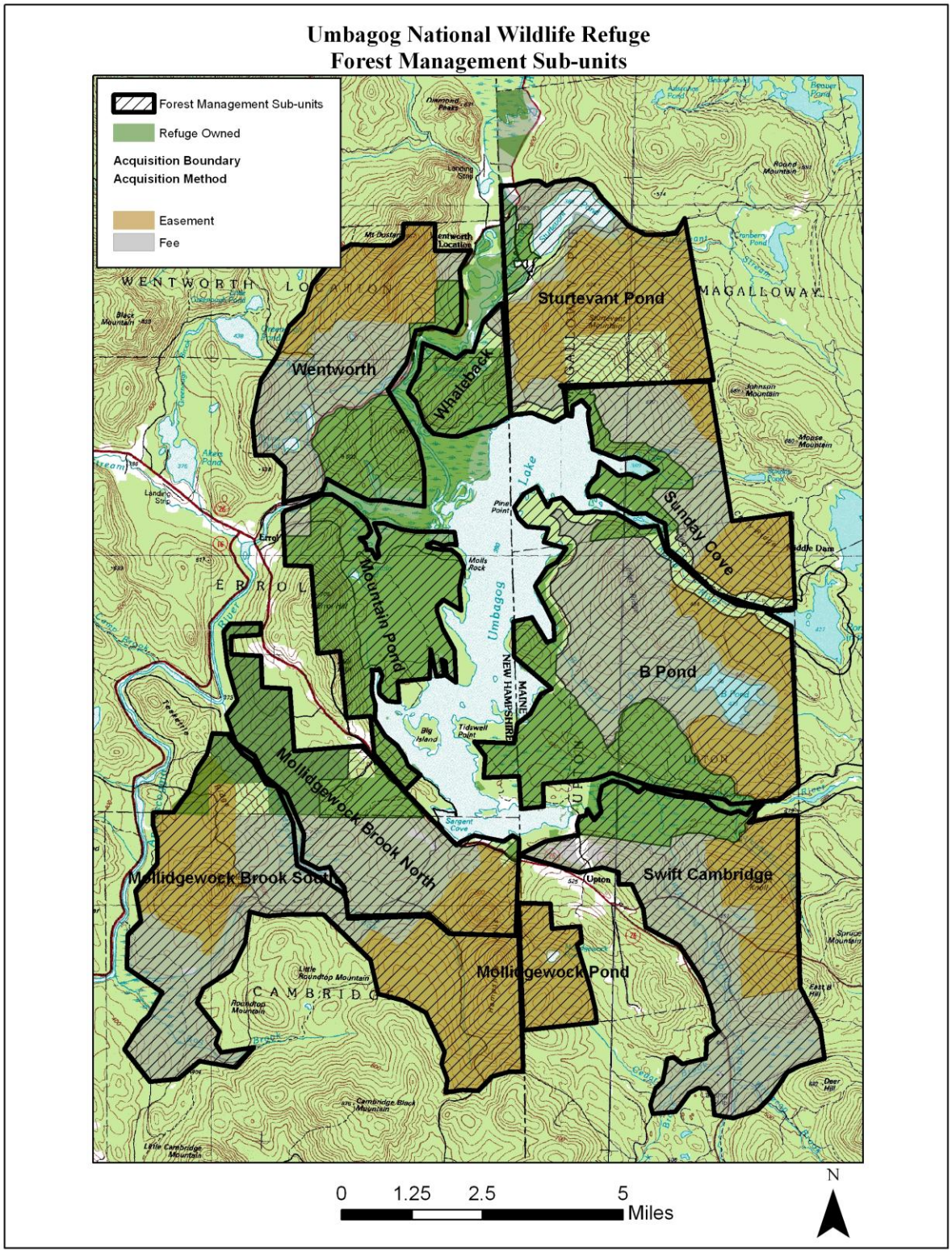
V. Woodcock Management Unit

Sub-Objective 3.1d (Woodcock Focus Areas
Manage 2,664 acres in woodcock focus areas to provide and sustain all life stage habitat requirements for woodcock. Refer to Map 4-4 for location of woodcock focus areas

Map 5-1. Umbagog NWR Management Units.



Map 5-2. Forest Management Sub-units.



Potential Prescriptions

This section summarizes some potential management practices for implementing the strategies identified in Chapter 4, and may be used to develop specific management prescriptions in the Annual Habitat Work Plans.

Forest Management

Spruce-fir

Desired future condition for focal species: Mature, closed canopy conifer with a high spruce component.

Uneven-aged Management

In the refuge's spruce-fir forested stands, we will utilize uneven-aged management techniques to convert the predominately even-aged forest to a multi-aged, multi-structured condition. We plan to conduct harvest utilizing a combination of group selection, with some single tree selection between groups. Groups should be roughly 1/10 acre in size and will be distributed throughout the entire management unit with 10-15% of the area being removed on 15-20 year cycles. Age class goals, not including reserve snag and cavity trees, will be 100-130 years. Basal area (BA) goals in spruce-fir should strive for a minimum of 80 ft^2/acre, with roughly 50% in 6-10" diameter class, 30% in 11-14" diameter class, and 25% in a 15"+ diameter class. Our spruce-fir structural goals are to maintain a q=1.7, which has about a 45% of its diameter distribution in an 11"+ diameter class. Use of the "q" is defined by Leak et al.:

Diameter distributions are approximated by the reverse J-shaped curve, with a slope defined by "q" – the quotient between numbers of tree in successively smaller d.b.h. classes."

We predict a stand at this stocking level will grow at a rate of 2 ft^2/ acre/year resulting in 30-40 ft^2/acre of volume available to harvest during each cutting cycle. Of this growth, we estimate retention of approximately 7 ft^2/ acre (approximately 6 trees/acre), to account for our snag and cavity tree requirements resulting in the potential removal of 23-33 ft^2/acre during each harvest entry.

It is expected a minimum net annual growth in this habitat will be .3 cords/acre/year which, over a 15-20 year period, equates to 4.5-6 cords/acre net increase. During each harvest entry, a portion of the trees need to be retained to fulfill our snag and cavity tree requirements. Individual trees (11"-20" diameter) are estimated to consist of .25 - 1 cord. It is predicted a retention volume of 2-3 cords/acre (1000-1500 BF/acre), distributed among 6 trees/acre, will be adequate to attain the desired snag/cavity tree goals. This results in roughly 2.5-4 cords/acre (1250-2000 BF/acre) available to harvest during each harvest cycle entry. Because our diameter distribution is skewed more towards the larger 11-14" class, it is predicted our gross volume will be 20-25 cords/acre at the beginning of each harvest cycle. With the predicted even distribution of volume per acre, this equates to 15 % area removal at each entry, accounting for 3-3.5 cords/acre, and any remaining volume/acre needed to meet the habitat goal, being removed through single tree selection.

Even-aged Management

In certain areas, such as where there is healthy, advanced spruce-fir regeneration or in critical deer wintering areas, we may employ even-aged management techniques in this habitat type. This is consistent with our objective to perpetuate a multi-aged and multi-structured forest landscape. We would conduct harvests utilizing shelterwood or clearcuts in a shifting mosaic pattern that will result in a progressive patch, block, or strip system, where-in typically 15% of the area is harvested in 15 – 20 year intervals.

Target rotation age is 80-130 years. On 15 year harvest cycles, and an approximate 100 year rotation, this equates to roughly 6 age classes with 33.3% of the area in a 0-30 year age class (regeneration/sapling

structural stage), 33.3% in a 30-60 year age class (pole/small sawtimber structural stage), and 33.3% in a 60-100 year age class (small sawtimber/large sawtimber structural stage). If no significant natural disturbance occurs during the rotation of a treatment area, basal area (BA) at the time of harvest will likely be above 140 ft²/acre, and may be in excess of 200 ft²/acre. Scheduling of a harvest is not basal area dependent, and is considered to be the size of the treatment area in its entirety, which is approximately 15% of the HMU.

Snag and cavity trees will need to be retained through a reserve approach during each harvest. We estimate retention of approximately 7 ft²/acre (e.g. approximately 6 trees/acre) to account for our snag and cavity tree requirements. Manipulative efforts through habitat improvement may need to be employed on adjacent areas to account for potential loss of this component from sudden exposure to sun, wind, storm, insect or other natural agents.

Harvest volume will vary greatly by site but 25 to 50 cords per acre is expected from 100 year old, unmanaged, fully stocked even-aged stands. Approximately 2 cords per acre will need to be retained for snag and cavity tree requirements.

Clearcuts on the refuge will be limited in size and typically less than 10 acres; or, in deer winter yards, clearcuts will be one of several regeneration methods used, but would not be applied on more than 20% of a deer wintering area within a 15-year interval.

Mixed Woods

Desired future condition for focal species: Mature, closed-canopy habitat with a high conifer (spruce-fir) component.

Silvicultural approaches will differ within the mixed spruce-fir/northern hardwood forest matrix based on the inherent capability of an individual site to grow a predominance of either spruce/fir or northern hardwoods (i.e. based on soil properties, moisture regimes, elevation, aspect, etc). Habitat types will be perpetuated through time, using accepted silvicultural practices. Where feasible, and assuming favorable site capability, management strategies will favor or increase the conifer component of stands.

Uneven-aged Management

In the refuge's mixed woods stands, we will primarily utilize uneven-aged management techniques to convert the predominately even-aged forest to a multi-aged, multi-structured, condition. We will conduct harvests utilizing a combination of group selection with some single tree selection between groups. Groups should range from 1/5 to 1/2 acre in size and be distributed throughout the entire management unit with 10-15% of the area being removed on 15-20 year cycles. Age class goals, not including snag and cavity trees, should be 100-200 years. BA goals in mixed woods should strive for a minimum of 100 ft²/acre with roughly 42% in a 6-10" diameter class, 28% in 11-14" diameter class, and 30% in a 15"+ diameter class. Mixed woods structural goals are to maintain a q = 1.5, which has about 55% of its diameter distribution in an 11"+ diameter class.

We predict a stand at this stocking level will grow at a rate of 2 ft²/ acre/year resulting in 30-40 ft²/ acre available to harvest during each cutting cycle. Of this growth, we estimate retention of approximately 7 ft²/acre (e.g. approximately 6 trees) to account for our snag and cavity tree requirements resulting in a removal of 23-33 ft²/ acre during each harvest entry.

We expect a minimum net annual growth in this habitat will be .33 cords/acre/year, which over a 15-20 year cutting cycle, equates to a 5-6.5 cords/acre net increase. During each harvest entry, a portion of the trees need to be retained to fulfill our snag and cavity tree requirements. Individual trees (11"-20" diameter) are estimated to consist of .25 - 1 cord. It is predicted a retention volume of 3 - 4.5 cords/acre

(1500-2250 BF/acre) distributed among 6 trees/acre will be adequate to retain the desired snag/cavity tree goals. This results in approximately 2-3 cords (1000-2000 BF/acre) available to harvest during each harvest cycle.

Because our diameter distribution is skewed more towards the larger 11-14" class, it is predicted our gross volume will be 18-22 cords/acre at the beginning of each harvest cycle. With the predicted even distribution of volume per acre this equates to 10 - 15 % area removal at each entry, accounting for 2 - 3.5 cords/acre, and the remaining volume/acre needed to meet the habitat goal, being removed through single tree selection.

Even-aged management

Where site conditions and management goals deem appropriate (deer wintering areas and areas where advanced spruce/fir regeneration exists), we will employ the even-aged management techniques as described for spruce/ fir management. These techniques will be used to perpetuate a multi-aged and multi-structured forest landscape through even-aged area regulation. We plan to conduct harvests utilizing shelterwood or clearcuts in a shifting mosaic pattern that will result in a progressive patch, block, or strip system, where-in 15% of the area is harvested in 15 – 20 year intervals.

Northern Hardwoods

Desired future condition for focal species: Mature, mid-high canopy closure, with a multi-layered profile, and canopy gaps with understory development.

Uneven-aged Management

In the refuge's northern hardwood stands, we will utilize uneven-aged management techniques to convert the predominately even-aged forest to a multi-aged, multi- structured condition. We will conduct harvests utilizing a combination of group selection with some single tree selection between groups. Groups would be approximately 1/2 acre in size and be distributed throughout the entire management unit with 10-15% of the area being removed on 15-20 year cycles. Age class goals, not including snag and cavity trees, should be 100200 years. BA goals in northern hardwoods should strive for a minimum of 70 ft^2/acre with roughly 42% in a 6-10" diameter class, 28% in 11-14" diameter class, and 30% in a 15"+ diameter class. Northern hardwoods structural goals are to maintain a q = 1.5, which has about 55 % of its diameter distribution in an 11"+ diameter class.

We predict a stand at this stocking will grow at a rate of 2 ft^2/ acre/year resulting in 30-40 ft^2/ acre available to harvest during each cutting cycle. Of this growth, we estimate retention of approximately 7 ft^2/acre (e.g. approximately 6 trees), to account for our snag and cavity tree requirements, resulting in a removal of 23-33 ft^2/acre during each harvest entry.

We expect a minimum net annual growth in this habitat will be .4 cords/acre/year, which over a 15-20 year period, equates to a 6-8 cords/acre net increase. During each harvest entry a portion of the trees need to be retained to fulfill our snag and cavity tree requirements. Individual trees (11"-20" diameter) are estimated to consist of .25 - 1 cord. We predict a retention volume of 2-3 cords/acre (1000-1500 BF/acre) distributed among 6 trees/acre will be adequate to attain the desired snag/cavity objectives. This results in approximately 4-6 cords (2000-3000 BF/acre) available to harvest during each harvest cycle entry.

Because our diameter distribution is skewed more towards the larger 11-14" class, it is predicted our gross volume will be 18-22 cords/acre at the beginning of each harvest cycle. With the predicted even distribution of volume per acre, this equates to 10-15 % area removal at each entry, accounting for 2 - 3.5 cords/acre, and the remaining volume/acre needed to meet the habitat goal, being removed through single tree selection.

Woodcock Focus Areas

Even-aged Management

In woodcock focus areas, we will use accepted silvicultural practices to create openings, promote understory development, and sustain early successional habitat for woodcock and Canada warbler. We will use group selection, clearcuts, or patch cuts of up to 5 acres in size. Some larger roosting fields may also be maintained. Cutting cycles will be approximately 8-10 years on a 40 year rotation. Some 3-5 acre openings may be permanently maintained, primarily by mowing and brush clearing using mechanized equipment. We will perpetuate the aspen-birch community where it currently exists, and maintain it in well-distributed regenerating, young, mid- and mature age classes.

Definitions of Forest Silvicultural Techniques and Methods to Use in our Forest Management for Focal Species:

Group Selection

This technique involves the removal of small groups of trees throughout a stand, to initiate and/or maintain an uneven-aged forest. A group selection opening is considered to be less than, or equal to, twice the height of the adjacent mature trees. This method will encourage regeneration of intermediately tolerant and tolerant species, but some intolerant species can appear towards the center of the harvest areas when the groups are at the maximum size. The likelihood of the harvest areas regenerating combined with the ability to schedule continual harvest entries, results in this technique being a method of choice to convert even-aged stands to uneven-aged stands when desired.

Group selection results in moderately- closed to closed-canopy conditions. Regeneration and shrubby vegetation can be expected to develop with reasonable assurance. This technique can be used in combination with singletree selection to ensure canopy closure requirements meet desired conditions. Priority species such as the blackburnian and black-throated green warbler will benefit from the application of this technique in a conifer-dominated habitat area. The predominantly closed canopy condition resulting from this technique will also benefit deer winter cover areas. The technique can be applied in all habitat types. Its application in the refuge's spruce-fir forest most closely resembles the natural disturbance that would be expected to take place if the area were allowed to develop without manipulation.

Single Tree Selection

This technique involves the removal of individual trees throughout a stand. Use of this technique, on a continual harvesting cycle, is considered uneven-aged management. It can also be used during even-aged management, and when done so, is commonly referred to as an intermediate thinning. In uneven-aged management, it is used to introduce small openings in the canopy by focusing the harvest on dominant, older aged trees. In even- aged management, it is used to promote the quality and growth of the remaining trees by focusing the harvest on poor quality, low vigor trees. The technique will likely result in varying quantities of regeneration of mostly shade tolerant species.

Single tree selection results in a relatively closed canopy condition. Understory development is usually minimal. The opportunity for regeneration is created but when trees are selected singularly, the opening produced in the canopy will typically be utilized quickly by the crowns of adjacent older trees. This technique is often used in combination with group selection to ensure regeneration is established and separate age classes are created to perpetuate the overall desired condition. In using single tree selection, with even-aged objectives in the form of a thinning, it will likely result in less opportunity for regeneration and understory development. Often times the suppressed and co-dominant trees are selected

for removal resulting in very little change in canopy closure after a treatment. This technique can be applied in all habitat types.

Pre-commercial Stand Treatments to Improve Habitat Conditions

These treatments include entering an even- or uneven-aged stand at any stage of development with the intent of tending to habitat needs through thinning, weeding, cleaning, liberation, sanitation, or other improvement methods. This technique can be used to control species composition and reduce an overabundance of stems per acre to a more desired stocking level. This can be applied through thinning young stands (pre-commercially) to control species composition, conducting intermediate thinnings in middle aged stands to maintain accelerated growth and remove unwanted vegetation, and prescribed fire. This technique may also be used to control stocking levels of habitat features such as snag trees, cavity trees, den trees, downed wood and other features through girdling, felling, boring, hinging, or other techniques.

This habitat improvement technique is varied in its application, but overall should be applied to alter or enhance young stands and introduce or reduce habitat features when goals and objectives are not being met. This can be applied in all habitat types and may be extended to areas that are not capable of supporting equipment for larger scale manipulation efforts.

Shelterwood System

This technique involves a series of harvests carried out with the intent of regenerating a stand utilizing mature trees that are removed at the end of the scheduled rotation. Essentially, the overstory is removed and the well-developed underlying regeneration then becomes the stand. This technique is typically used to regenerate intermediately tolerant (mid-successional) and tolerant (late successional) species, but in certain instances can be used for intolerant (early successional) species. Use of this technique is considered even-aged management, although variations more often found in the irregular shelterwood system can result in a multi-aged stand. In order for a shelterwood system to be considered, a stand should be reasonably well stocked with a moderate to high component of the species desired for regeneration.

A number of shelterwood system applications exist. The more commonly used is the open shelterwood system. Although less commonly used, the dense shelterwood, deferred shelterwood, irregular shelterwood, natural shelterwood, and nurse tree shelterwood systems are also useful in accomplishing specific regenerative needs as well as other resource management objectives.

The shelterwood variations allow a variety of habitat conditions to be created while fulfilling the regenerative objectives of the technique. It can be used to create a denser crown closure when connectivity of an older age forest needs to be maintained. The amount of time needed to establish regeneration and conduct the overstory removal can provide enough time for other areas to develop into an older age condition, and ensure refuge goals are being met continually. Overstory removal can be delayed through a deferred shelterwood if further development of other areas is necessary. It can also be used to create a more open crown closure when development of a shrub component in the understory is desired or residual tree are needed to meet specific habitat requirements. Once regenerative needs have been reached and the “shelter” (seed) trees have been removed, the new stand can then be managed for structural objectives as it develops. Overstory removal can result in a regenerative condition which does offer some early successional benefits as described in the clearcut technique.

This technique can be used in all habitat types. Its application on habitats comprised of predominately shallow root species (e.g. red spruce/balsam fir) or wet soil conditions, does introduce a greater susceptibility of the residual trees to windthrow from wind events.

Clearcutting

This technique involves the removal of an entire stand of trees in one cutting to obtain natural reproduction. Two common methods of clearcutting are patch or block clearcuts, and strip clearcuts. This regeneration technique is considered to be even-aged management, although somewhat coarse multi-aged stands can be developed through progressive patch or progressive strip clearcut systems. Clearcut size does have an effect on regeneration. As clearcuts increase in size, they tend to favor shade intolerant regeneration. As they become smaller they gravitate towards encouraging intermediately tolerant and tolerant species.

Clearcuts are often used to create an early successional habitat condition. Early successional habitat is when an area is in a young, shrubby, regenerating condition that covers an area large enough to be recognized and perhaps utilized by wildlife or plants associated with such an open or no-canopy condition.

This technique should be utilized when an early successional habitat condition is desired and found to be lacking or not available within the landscape. As mentioned previously in this description, clearcut size does have an impact on tree species composition, and therefore should also be utilized when current species composition is not desired or diverse enough to reach goals and objectives. This technique can be used in all habitat types, and although somewhat limiting in terms of emulating natural processes or conditions, can be used in a continual, progressive system that sustains multiple age classes

Invasive Plant Control

Although invasive plants are not a major problem on the refuge at this time, small patches of purple loosestrife, Japanese knotweed, and phragmites have been observed in certain locations, primarily on disturbed sites, often near roads.

Manual and Mechanical Control

Mechanical removal of invasive organisms can be effective against some herbaceous plants, shrubs and saplings, and aquatic organisms. This is particularly effective for plants that are annuals or have a taproot. Care should be taken to minimize soil disturbance to prevent creating conditions ideal for weed seed germination. Repeated cutting over a growing period is needed for effective control of many invasive plant species. Care should be taken to properly remove and dispose of any plant parts that can re-sprout. Treatments should be timed to prevent seed set and re-sprouting. The following methods are available: hand-pulling, pulling with hand tools (weed wrench, etc.), mowing, brush-hogging, weed-eating, stabbing (cutting roots while leaving in place), girdling (removing cambium layer), mulching, tilling, smothering (black plastic or other), and flooding.

The advantages of mechanical treatment are low cost for equipment and supplies and minimal damage to neighboring plants and the environment. The disadvantages are higher costs for labor and inability to control large areas. For many invasive species, mechanical treatments alone are not effective, especially for mature plants or well-established plants. For some invasive plants, mechanical treatments alone exacerbate the problem by causing vigorous suckering**.** Mechanical treatments are most effective when combined with herbicide treatments (e.g. girdle and herbicide treatment).

Herbicides

There are a wide variety of chemicals that are toxic to plant and animal species. They may work in different ways and be very target specific, or affect a wide range of species. Herbicides may be "pre-emergent," that is, applied prior to germination to prevent germination or kill the seedling, or "post-emergent" and may have various modes of action (auxin mimic, amino acid inhibitor, mitosis inhibitor, photosynthesis inhibitor, lipid biosynthesis inhibitor). Products may come in granular, pelleted, dust or

liquid forms. Liquid herbicides are commonly diluted to an appropriate formula and mixed with other chemicals that facilitate mixing, application or efficacy. Common application methods include foliar spray, basal bark, hack and squirt, injection, and cut stump.

The advantages are that the correct chemicals, applied correctly, can produce desired results over a large area for a reasonable cost. The disadvantages are that the chemicals may affect non-target species at the site (including the applicator) and/or contaminate surface or groundwater. Proper planning includes using the most target-specific, least hazardous (humans and the environment), and most effective chemical for the job. Additionally, attention to protective gear, licensing requirements and other regulations and is essential. Herbicides are most effective when used in combination with non-chemical methods described above.

Seasonal Closures

The seasonal closure of nesting and foraging areas may be necessary to protect sensitive nesting bird species and habitats on the refuge, such as loons. Posting "area closed" signs near bird nesting areas, nesting islands, or individual nest locations, is one way to help prevent disturbance caused by humans and boats. Signs are placed in the appropriate areas as soon as possible in the spring and are maintained throughout the nesting season. If disturbance is noted by refuge staff, additional areas may be posted as well.

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Appendix A. Habitat Classifications

Habitat Definition

A National Goals Team was created to develop a process for implementing wildlife and habitat recommendations of *Fulfilling the Promise* (USFWS 1999). In a draft report (Czech and Murphy 2003), the Team crafted the following "habitat" definitions:

> **1) The suite of biotic and abiotic resources used by a species during the course of its natural history.** For animal species, these resources generally include food, water, cover, space, and special, species-specific resources necessary for survival and reproduction (e.g., nesting cavities for cavity-nesting birds) or conducive to health and vigor (e.g., mineral deposits for ungulates). For plant species, these resources generally include soils, water, topography, and special species-specific resources necessary for survival and reproduction (e.g., pollinators for flowering plants) or conducive to health and vigor (e.g., cryptogrammic soils for legumes).
>
> **2) A vegetative community or physiographically categorizable area serving as a conglomerate of species-specific habitats.** For example, a "ponderosa pine forest habitat" in the Southwest typically includes the biotic and abiotic features conducive to supporting ponderosa pine, cliffrose, Arizona fescue, elk, wild turkey, timber rattlesnakes, and other species. Used in this sense, habitat is roughly synonymous with "habitat type," "plant community," and "ecosystem," depending upon context. It may be used at any level of detail coarser than species-specific. For example, one may refer to the various associations, formations, or even classes of the National Vegetation Classification System as "habitats."

Vegetation Classifications

Ecologists and biologists describe and map vegetation patterns (i.e., "habitats") using a variety of classification systems. These systems differ in their scale of application and purposes. Refuges are developing a consistent methodology for classifying habitats that enables managers and biologists to identify management units at a fine scale as well as describe a refuge's role in the regional landscape.

The National Vegetation Classification System (NVCS) was established as the standard classification framework for vegetation by federal agencies in the United States. The USFWS is using the NVCS, a seven level hierarchical system developed by The Nature Conservancy (TNC) and Natural Heritage Network in the 1990s, to map habitats on National Wildlife Refuges. NVCS is based on existing vegetation and classifies "natural" vegetation types, although it can be used to classify human-modified lands. Aerial photo interpretation and ground truthing are used to map vegetation to the "Alliance" level in the NVCS. Fine scale mapping to the "Association" level often requires more intensive field survey (Maybury 1999).

Mapping vegetation patterns with a consistent classification system (i.e., NVCS) provides the foundation for evaluating inventory, monitoring, and management programs over time and across regions. These programs may include searches for federally endangered species, locating long-term monitoring plots, monitoring restoration efforts, tracking long-term vegetation changes, as well as enabling the roll-up of these data into a regional or national summary (Maybury, 1999). For a comparison of NVCS to other vegetation classification systems see Grossman et al. (1998).

Ecological Systems

NatureServe defines an Ecological System as a natural group of plant associations occurring together on the ground, unified by the same set of ecological processes, substrates, and environmental

gradients. The NVCS groups associations into alliances based on the common dominant or diagnostic plant species regardless of whether they may co-occur on the landscape. In contrast, ecological systems are groupings of NVCS associations or alliances that are found together. Rather than hierarchical, there is a set of ecological system types. They are intended to provide a classification unit that can be mapped more readily from remote imagery, yet are easily identifiable by resource managers in the field (Comer et al. 2003).

Associations can belong to more than one Ecological System. Highly altered vegetation is not defined as a System, but as a cover type. Aquatic systems are not yet defined in Ecological Systems. Because Ecological Systems are based on Associations in the NVCS, they conform to the Federal Geographic Data Committee (FDGC). NVCS is a taxonomic system not specifically designed for mapping, so aggregating associations into system units addresses mapping challenges presented by the predominantly forested New England region. Many forest Alliances are roughly equivalent to the Society of American Foresters (SAF) cover types.

Landscape-Scale Classification Systems

The physical environment, expressed through climate, geology, topography or landform and soils, explains much about the patterns and distribution of biological diversity. These patterns describe natural divisions, called biophysical or ecological regions, that inform our efforts to understand, conserve, and manage biodiversity. The Nature Conservancy (TNC) has divided the continental United States into 63 ecoregions, large geographic areas that share similar geologic, topographic, ecological, and climatic characteristics. These ecoregions are modified from the U.S. Forest Service "Bailey" System (Bailey 1995).

Partners in Flight (PIF) uses *physiographic areas* as its spatial planning unit. Under the North American Bird Conservation Initiative (NABCI), PIF, North American Waterfowl Management Plan, U.S. Shorebird Conservation Plan, and the North American Waterbird Conservation Plan Initiatives worked together to develop a standard map of planning regions to enhance communication and enable integrated bird conservation. Bird Conservation Regions (BCRs) now serve as the common spatial unit for all bird conservation. BCRs are ecologically distinct regions in North America with similar bird communities, habitats, and resource management issues. They can be partitioned into smaller ecological units or aggregated depending on the scale of conservation planning.

Refuges play a critical but sometimes limited role in wildlife conservation in many ecosystems. One way to optimize the goals and objectives on a particular refuge is to view it in a broader (landscape) context and in concert with the efforts of other public and private natural resource management partners (Czech and Murphy 2003). Ecoregions and BCR and PIF regions provide a consistent ecological framework and enable partners to generate a regional and national synopsis.

Ecological Land Units

Ecological Land Units (ELUs) is a system of land classification developed by TNC that characterizes the land based on three physical factors that influence the type of plant communities that may be found there—elevation, bedrock geology, and topography (Publicover and Weihrauch 2003). TNC's ecological land units are not part of the ecoregion hierarchical framework, but rather it is a GIS mapping tool to depict the underlying features that determine vegetation patterns and one measure of site capability.

I. Site Capability

The National Land Cover Data (NLCD) and other cover type maps show current land use and vegetative cover. Although important, these maps need to be combined with "potential" or "natural" vegetation maps to depict the inherent potential of a site (Westveld et al. 1956, Kuchler 1964).

Kuchler (1964) noted the importance of distinguishing between the vegetation that exists at the present time of observation and the potential natural vegetation that will occupy a site without disturbance or climatic change. Potential natural vegetation (or site capability) is based on the expression of environmental factors such as topography, soils, and climate. TNC's Ecological Land Units (ELU) is a refinement of Kuchler's units. Westveld et al. (1956) used a combination of present cover types in conjunction with their topographic position and knowledge of successional stages in forest growth to map natural vegetation zones of New England.

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Appendix B. Species and Habitats of Conservation Concern

Species	Federal Legal Status[1]	NH Legal Status[1]	ME Legal Status[1]	NH Wildlife Action Plan[2]	Maine CWCS[3]	NH Rarity Rank[4]	ME Rarity Rank[4]	BCC 2002[5]	BCR 14: Atlantic Northern Forests	PIF[6]	NAW-CP[7]	NAWMP ACJV[8]	U.S. SCP[9]	Breeding Status[10]
Alder Flycatcher										IV				B
American Bittern				x	2	S3B			Moderate Priority	IV				B
American Black Duck				x	2				Highest Priority	IA		High Priority (B); Highest Priority (NB)		B
American Kestrel										IV				B
American Pipit		SC	E(PEB)	x			S3N							
American Redstart					3				High Priority					B
American Three-toed Woodpecker		T	SC	x	2	S1	S3			IV				
American Wigeon					3		S3N							
American Woodcock				x	2				Highest Priority	IA			4	B
Bald Eagle		E(PT)	T	x	2	S1	S4B		Moderate Priority	III				B
Baltimore Oriole					2									B
Bank Swallow					3				Moderate Priority					B
Barn Swallow					2				Moderate Priority					B
Barred Owl					2									B
Barrow's Goldeneye			SC(PT)		2		S2S3N		Highest Priority					
Bay-breasted Warbler				x	2			x	Highest Priority	IA				B

Species	Federal Legal Status[1]	NH Legal Status[1]	ME Legal Status[1]	NH Wildlife Action Plan[2]	Maine CWCS[3]	NH Rarity Rank[4]	ME Rarity Rank[4]	BCC 2002[5]	BCR 14: Atlantic Northern Forests	PIF[6]	NAW-CP[7]	NAWMP ACJV[8]	U.S. SCP[9]	Breeding Status[10]
Black and White Warbler					2									B
Black-bellied Plover					3		S3S4N		High Priority				3	
Black Scoter					3		S3S4N		High Priorty					
Black Tern			E		1						Moderate concern			
Black-backed Woodpecker					3	S3S4			Moderate Priority	IV				B
Black-billed Cuckoo					2				Moderate Priority					B
Blackburninan Warbler					2				Moderate Priority					B
Blackpoll Warbler					3			x	Moderate Priority	IV				
Black-throated Blue Warbler					2				High Priority	IIB				B
Black-throated Green Warbler					2				Moderate Priority					B
Blue-winged Teal					3	S3B				IV		Moderately High Priority		B
Bobolink					2				High Priority	IIA				B
Bohemian Waxwing							S3S4N							
Bonaparte's Gull											Moderate concern			
Boreal Chickadee									High Priority					B
Broad-winged Hawk					3									B

Species	Federal Legal Status[1]	NH Legal Status[1]	ME Legal Status[1]	NH Wildlife Action Plan[2]	Maine CWCS[3]	NH Rarity Rank[4]	ME Rarity Rank[4]	BCC 2002[5]	BCR 14: Atlantic Northern Forests	PIF[6]	NAW-CP[7]	NAWMP ACJV[8]	U.S. SCP[9]	Breeding Status[10]
Brown Creeper									Moderate Priority					B
Brown Thrasher					2	S3				IV				B
Bufflehead												Moderately High (NB)		
Canada Warbler				x	2			x	Highest Priority	IA				B
Cape May Warbler					2			x	High Priority	IIB				B
Chestnut-sided Warbler					2			x	High Priority	IIA				B
Chimney Swift					2				High Priority					B
Common Goldeneye					3	S3B			Moderate Priority					B
Common Loon		T		x	2	S3B			Moderate Priority	IV				B
Common Moorhen			SC(PT)	x	2	S2								
Common Nighthawk		T(PE)		x	2				High Priority	IV				
Common Raven										IV				B
Common Tern		E(PT)	SC	x	2	S1		x	High Priority	IIA				
Common Yellowthroat					3									B
Cooper's Hawk		T(PN)	SC	x	3	S2B	S3S4B			IV				B
Dunlin							S3N						3	
Eastern Kingbird					2									B
Eastern Meadowlark			SC	x	2					IV				
Eastern Wood-Pewee					3				High Priority	IV				
Evening Grosbeak					3									B

Species	Federal Legal Status[1]	NH Legal Status[1]	ME Legal Status[1]	NH Wildlife Action Plan[2]	Maine CWCS[3]	NH Rarity Rank[4]	ME Rarity Rank[4]	BCC 2002[5]	BCR 14: Atlantic Northern Forests	PIF[6]	NAW-CP[7]	NAWMP ACJV[8]	U.S. SCP[9]	Breeding Status[10]
Field Sparrow					2	S3	S3S4B							B
Fox Sparrow					3		S2N							
Golden Eagle		E	E	x	2	SHB	S1N			IV				
Gray Jay									Moderate Priority	IV				B
Great Black-backed Gull					3									
Great Blue Heron				x	2									B
Great Cormorant			SC(PTB)				S3N		Highest Priority		Mod-erate con-cern			
Great-crested Flycatcher					2									B
Greater Scaup					2		S3S4N		Moderate Priority			High (NB)		
Greater Yellowlegs					2								3	
Green Heron					3									
Green-winged Teal					3	S3B								B
Herring Gull					3				High Priority					B
Hooded Merganser												High Priority		B
Horned Grebe					3				Moderate Priority					
Horned Lark				x			S3S4N		Moderate Priority	IV				
Killdeer					3				Moderate Priority				3	B
Lapland Longspur							S2S3N							
Least Flycatcher					3									B

Species	Federal Legal Status[1]	NH Legal Status[1]	ME Legal Status[1]	NH Wildlife Action Plan[2]	Maine CWCS[3]	NH Rarity Rank[4]	ME Rarity Rank[4]	BCC 2002[5]	BCR 14: Atlantic Northern Forests	PIF[6]	NAW-CP[7]	NAWMP ACJV[8]	U.S. SCP[9]	Breeding Status[10]
Least Sandpiper									Moderate Priority				3	
Lesser Scaup					3		S1S3N					High (NB)		
Lesser Yellowlegs													3	
Long-tailed Duck					3				Moderate Priority					
Mallard					3							High Priority (B) Moderate Priority (NB)		B
Marsh Wren					2	S3								B
Merlin					3	S3B	S3B							B
Morning Warbler										IV				B
Northern Flicker					2				Moderate Priority					B
Northern Goshawk			SC	x	3	S3	S3?B		Moderate Priority	III				B
Northern Harrier		E		x	3	S2B			Moderate Priority	IV				B
Northern Parula					2				Moderate Priority	IIB				B
Northern Pintail					3		S3S4N					Moderate Priority (NB)		
Northern Saw-whet Owl										IV				B
Northern Shrike							S2S3N							
Olive-sided Flycatcher			SC		2			x	High Priority	IB				B
Osprey		T		x		S2B				IV				B

Species	Federal Legal Status[1]	NH Legal Status[1]	ME Legal Status[1]	NH Wildlife Action Plan[2]	Maine CWCS[3]	NH Rarity Rank[4]	ME Rarity Rank[4]	BCC 2002[5]	BCR 14: Atlantic Northern Forests	PIF[6]	NAW-CP[7]	NAWMP ACJV[8]	U.S. SCP[9]	Breeding Status[10]
Ovenbird					3				Moderate Priority	IIB				B
Palm Warbler				x	3	S3B			Moderate Priority					B
Pectoral Sandpiper							S2S3N							
Peregrine Falcon		E(PT)	E(PEB)	x	1	S1	S2B	x	Moderate Priority	III				B
Pied-billed Grebe		E(PT)		x	2	S1B				IV				B
Pine Grosbeak									Moderate Priority					
Purple Finch				x	2				High Priority	IIA				B
Red Crossbill					2		S3S4B							B
Red-necked Grebe							S3S4N		High Priority					
Red-necked Phalarope			SC		2		S3S4N		Highest Priority				3	
Red-shouldered Hawk		SC		x	3	S3	S3N			III				
Red-throated Loon					3		S2S3N		Moderate Priority					
Ring0necked Duck					3	S3B								B
Rose-breasted Grosbeak					2				Moderate priority	IIA				B
Rough-legged Hawk							S2S3N							
Ruffed rouse				x	3				Moderate Priority					B
Rusty Blackbird		SC	SC	x	2	S2	S3S4B		High Priority	!A				B
Sanderling					2				Moderate Priority				4	
Savannah Sparrow										III				B
Scarlet Tanager					2									B

Species	Federal Legal Status[1]	NH Legal Status[1]	ME Legal Status[1]	NH Wildlife Action Plan[2]	Maine CWCS[3]	NH Rarity Rank[4]	ME Rarity Rank[4]	BCC 2002[5]	BCR 14: Atlantic Northern Forests	PIF[6]	NAW-CP[7]	NAWMP ACJV[8]	U.S. SCP[9]	Breeding Status[10]
Semipalmated Plover									Moderate Priority					
Semipalmated Sandpiper				x	2				highest Priority				3	
Sharp-shinned Hawk							S3S4B			IV				B
Short-billed Dowitcher					3				High Priority				4	
Snow Goose							S3N							
Solitary Sandpiper					3		S3S4N						4	
Sora					3	S3B				IV				B
Spruce Grouse				x	3	S3				IIA				B
Surf Scoter					3		S3S4N		Moderate Priority			Moderately High (NB)		
Tennessee Warbler					3									B
Tree Swallow					3									B
Turkey				x										
Veery				x	2				High Priority	IIA				B
Virginia Rail					3									B
Whip-poor-will		SC		x	2				Moderate Priority	IV				
White-throated Sparrow					3									B
White-winged Crossbill					3		S3S4B							B
White-winged Scoter					3							Moderately High (NB)		
Wilson’s Snipe													3	B
Wilson’s Warbler						S3B	S3S4B			IV				B

Species	Federal Legal Status[1]	NH Legal Status[1]	ME Legal Status[1]	NH Wildlife Action Plan[2]	Maine CWCS[3]	NH Rarity Rank[4]	ME Rarity Rank[4]	BCC 2002[5]	BCR 14: Atlantic Northern Forests	PIF[6]	NAW-CP[7]	NAWMP ACJV[8]	U.S. SCP[9]	Breeding Status[10]
Wood Duck									Moderate Priority			High Priority (B, NB)		B
Wood Thrush				x	2			x	Highest Priority	IB				B
Yellow-bellied Flycatcher									Moderate Priority					B
Yellow-bellied Sapsucker					2				High Priority					B
Yellow Warbler					3									B

[1]Federal and State Legal Status Codes (under Federal & State Endangered Species Acts)

E = Federal or State Endangered T= Federal or State Threatened SC= State species of Special Concern (Administrative category without legal standing) PT = Proposed Threatened PE= Proposed Endangered PN= Proposed None PTB= Proposed threatened (breeding only) PEB= Proposed Endangered (breeding only)

[2]N.H. Wildlife Action Pan: Species of greatest conservation concern

[3]Maine's Comprehensive Wildlife Conservation Plan

Priority 1 (Very High) = High potential for state extirpation without management intervention and/or protection.
Priority 2 (High) = Moderate to high potential for state extirpation without management intervention and/or protection.
Priority 3 (Moderate) = Low to moderate potential for state extirpation, YET, there are some remaining concerns regarding restricted distribution, status, and/or extreme habitat specialization.

[4]New Hampshire and Maine Natural Heritage Inventory Rarity Ranks

S1 = Critically imperiled
S2 = Imperiled
S3 = Either very rare or uncommon, vulnerable
S4 = Widespread, abundant, apparently secure
S5= Secure
SH = Historical.
B = Breeding
N = Non-breeding
Species included in table only if Srank in either state < S3

[5]Birds of Conservation Concern 2002 (Bird Conservation Region 14 List)

[6]Partners in Flight Bird Conservation Plan for Eastern Spruce-Hardwood Forest: Physiographic Area 28, 2003 Update Codes

IA = High continental concern & high regional responsibility
IB = High continental concern & low regional responsibility
IIA = High regional concern
IIB = High regional responsibility
III = Additional Federal listed
IV = Additional State listed

[7]North American Waterbird Conservation Plan Categories of Conservation Concern

Highly Imperiled: includes all species with significant population declines and either low populations or some other high risk factor.
High Concern: Species that are not Highly Imperiled. Populations of these species are known of thought to be declining, and have some other known or potential threat as well.
Moderate Concern: Species that are not highly Imperiled or High Concern. Populations of these species are either a) declining with moderate threats or distributions; b) Species included in table only if > moderate

[8]North American Waterfowl Management Plan, Atlantic Coast Joint Venture
B = breeding species prioritization
NB = non-breeding species prioritization
Conservation Tier Priorities = Highest, High, Moderately High, Moderate, Moderately Low, Low
Species included in table only if priority moderate or higher

[9]U.S. Shorebird Conservation Plan Codes
5 = Highly imperiled
4 = Species of high concern
3 = Species of moderate concern
2 = Species of low concern
1 = Species not at risk
Species included in table only if >3

[10]Breeding Status
(B= Breeds on Refuge)

Species and Habitats of Conservation Concern Known or Suspected on the Refuge – Mammals List

Common Name	NH Legal Status[1]	ME Legal Status[1]	NH Wildlife Action Plan[2]	Maine CWCS[3]	NH Rarity Rank[4]	ME Rarity Rank[4]
American Beaver				3		
Big Brown Bat		SC		3		
Bobcat	SC		x			
Black Bear			x			
Hoary Bat	SC	SC	x	3		
Little Brown Bat		SC		3		
Marten	T		x		S2	S5
moose			x			
Northern Long-eared Bat		SC	x	3		
White-tailed Deer			x			

[1]New Hampshire and Maine State Legal Status (under State Endangered Species Act)

E = Endangered T = Threatened SC = Species of Special Concern (Administrative category without legal standing)

[2]New Hampshire Wildlife Action Plan: Species of greatest conservation concern (bear, moose, white-tailed deer in NH Big Game Plan)

[3]Maine's Comprehensive Wildlife Conservation Strategy

Priority 1 (Very High) = High potential for state extirpation without management intervention and/or protection.
Priority 2 (High) = Moderate to high potential for state extirpation without management intervention and/or protection.
Priority 3 (Moderate) = Low to moderate potential for state extirpation, there are some remaining concerns regarding restricted distribution, status, and/or extreme habitat specialization.

[4]New Hampshire and Maine Natural Heritage Inventory Rarity Ranks

S1 = Critically imperiled.
S2 = Imperiled
S3 = Either very rare or uncommon, vulnerable
S4 = Widespread, abundant, apparently secure
S5 = Secure
SH = Historical

Species and Habitats of Conservation Concern Known or Suspected on the Refuge – Fish List

Common Name	NH Wildlife Action Plan[1]	Maine CWCS[2]	NH Rarity Rank[3]	ME Rarity Rank[3]
Alewife	x			
American Eel	x	1		
Eastern Brook Trout	x	2		
Finescale Dace (?)	x		S2	S4
Lake Chub		3		
Lake Trout	x	1		
Lake Whitefish	x		S3	
Landlocked Atlantic Salmon	x	2		S3
Longnose sucker		2		
Northern Redbelly	x		S3	
Rainbow Smelt	x	2		
Slimy Sculpin	x	3		

? = occurrence at Lake Umbagog not confirmed in recent years

1New Hampshire Wildlife Action Plan: Species of greatest conservation concern

2Maine's Comprehensive Wildlife Conservation Strategy

Priority 1 (Very High) = High potential for state extirpation without management intervention and/or protection.
Priority 2 (High) = Moderate to high potential for state extirpation without management intervention and/or protection.
Priority 3 (Moderate) = Low to moderate potential for state extirpation, there are some remaining concerns regarding restricted distribution, status, and/or extreme habitat specialization

3New Hampshire and Maine Natural Heritage Inventory Rarity Ranks

S1 = Critically imperiled
S2 = Imperiled
S3 = Either very rare or uncommon, vulnerable
S4 = Widespread, abundant, apparently secure
S5= Secure
SH = Historical

Species and habitats of Conservation Concern Known or Suspected on the Refuge – Amphibians & Reptiles List

Common Name	NH Legal Status[1]	ME Legal Status[1]	NH Wildlife Action Plan[2]	ME CWCS[3]
Amphibians				
Blue-spotted Salamander			x	2
Mink Frog			x	
Northern leopard Frog	SC	SC	x	3
Spring Salamander		SC		3
Reptiles				
Wood Turtle	SC	SC	x	2

[1]State Legal Status (under State Endangered Species Acts)

E = Endangered T = Threatened SC = Species of Special Concern (Administrative category without legal standing)

[2]New Hampshire Wildlife Action Plan: Species of greatest conservation concern

[3]Maine's Comprehensive Wildlife Conservation

Priority 1 (Very High) = High potential for state extirpation without management intervention and/or protection.
Priority 2 (High) = Moderate to high potential for state extirpation without management intervention and/or protection.
Priority 3 (Moderate) = Low to moderate potential for state extirpation, there are some remaining concerns regarding restricted distribution, status, and/or extreme habitat specialization.

[4]New Hampshire and Maine Natural Heritage Inventory Rarity Ranks
S1 = Critically imperiled
S2 = Imperiled
S3 = Either very rare or uncommon, vulnerable
S4 = Widespread, abundant, apparently secure
S5 = Secure
SH = Historical.

Species and Habitats of Conservation Concern Known or Suspected on the Refuge – Plant List

Common Name	NH Legal Status	ME Legal Status[1]	NH Rarity Rank[2]	ME Rarity Rank[3]
Dragon's mouth	T		S2	
Golden sedge	E		S1	
Creeping sedge	E		S1	
Meagre sedge	E		S1	
Hayden's sedge			S3	
Livid sedge	E	SC	S1	S2
Sparse-flower sedge	E	SC	S1	S2
American willow-herb			Ind	
Narrow-leaved cotton grass	E		S1	
Marsh horsetail	E		S1	
Hollow Joe pye weed	E	SC	S1	S2
Moor rush	E	SC	S1	S2
Broad-leaved twayblade	T		S2	
Heart-leaved twayblade	T		S2	
Water lobelia			S3	
Alternative-flowered water milfoil			S3	
Comb water milfoil			S3	
Slender waternymph			Ind	
Dwarf ragwort	T		S2	
Jack pine	E		S1	
Knotty pondweed	E		S1	
Budding pondweed	E		SH	
Pink wintergreen	E		S1	
Arrow-head (wapato)	E		SH	
Bog willow			S3	
Satin willow	E		S1	
Podgrass			S3	

Torrey's threesquare			S3	
Stiffly hairy goldenrod			Ind	
Pursh's goldenrod			Ind	
Branched bur-reed	E		SH	
Contorted sphagnum peat moss	T		S2	
Peat moss			S3	
Floating bladdersort			A3	
Canada violet		E		S1

? = occurrence at Lake Umbagog not confirmed

[1]State Legal Status (Under State Endangered Species Acts)

E = Endangered
T = Threatened
SC = Special Concern (Administrative category without legal standing)

[2]New Hampshire & Maine Natural Heritage Inventory State Rarity Ranks

S1 = critically imperiled
S2 = imperiled
S3= rare or uncommon; state watch species
S4 = widespread & apparently secure
S5 = widespread & secure
SH = historical
Ind = indeterminate (thought to be rare but in need of more information to determine status)

Species and Habitats of Conservation Concern Known or Suspected on the Refuge – Plant Communities List

New Hampshire Community Type	NH Natural Heritage Inventory State Rarity Rank	ME Natural Areas Program State Rarity Rank	Maine Community Type
Acidic northern white cedar swamp	S1	S4	Northern white cedar swamp
Leather-leaf-black spruce bog	S3		
Circumneutral-calcareous flark	S1	S2	Shrubby cinquefoil-sedge circumneutral fen
Lowland spruce-fir forest	S3	S4	Spruce-fir broom-moss forest
Northern hardwood-black ash-conifer swamp	S2		
Norther white cedar-balsam fir swamp	S2	S4	North white cedar swamp
Silver maple-false nettle-sensitive fern floodplain forest	S2		
Large cranberry-short sedge moss lawn (sphagnum pulchrum-quagmire sedge variant)	S3		
Sphagnum rubellum- small cranberry moss carpet	S3		
Large cranberry- short sedge moss lawn (sphagnum torreyanum variant)	S3		
Northern white cedar circumneutral sting	S1	S4	Northern white cedar woodland fen
Highbush blueberry-mountain holly wooded fen	S3S4		

New Hampshire Heritage Inventory Exemplary Natural Communities: Open Peatland Complexes

Site
Borderline Fen (patterned fen system)
Harper's Meadow (medium level fen system)
Leonard Marsh (medium level fen system)
Sweat meadows (medium level fen system)
Whaleback Ponds (poor level fen/bog system)

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